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CHEMICAL & METALLURGICAL ENGINEERING

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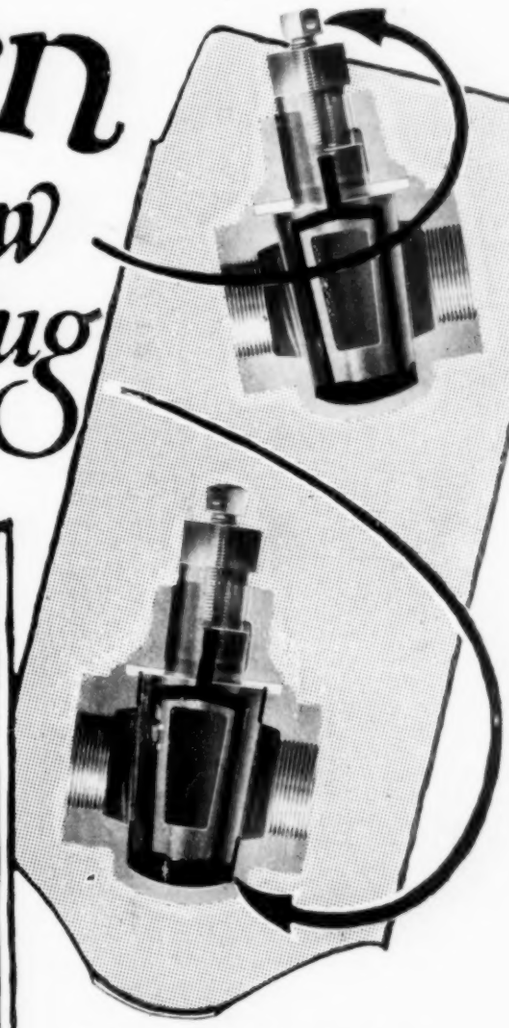

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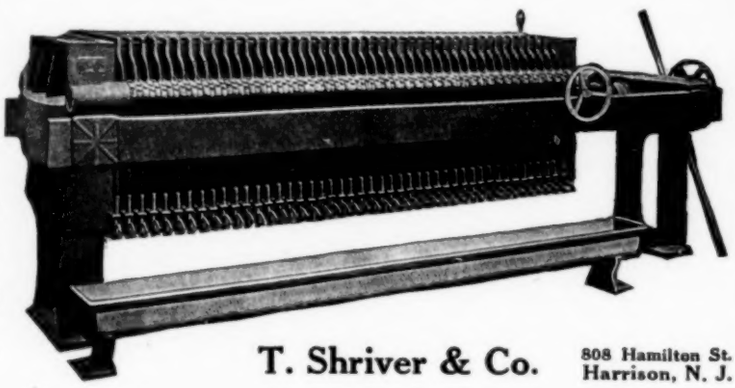

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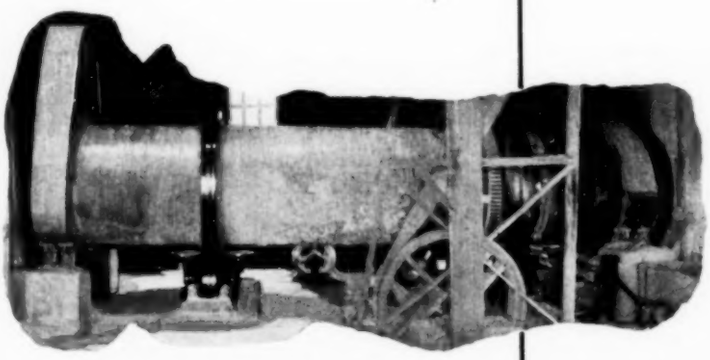

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International Migration of Technical Men And the Diffusion of Manufacturing Secrets

INTERPLANT migration of technical men and diffusion of manufacturing secrets are concomitant. Business ethics limits the practice, but there are conditions where good business demands that there be some migration with accompanying diffusion. Every plant manager knows that the employee who will sell the secrets of his former employer is not a safe repository for his own carefully guarded manufacturing methods. He is convinced that he must not start the subsidizing of crookedness by bidding higher for his competitor's men. But should conditions arise within the works of his competitor that caused men to resign of their own free will and come to him seeking employment he would be a weak business competitor if he did not hire any of them he wanted.

This very condition exists today between the German and American dye companies. There are a few German chemists who, recognizing that the monopoly, and consequent prosperity, of their home industry is at an end, are seeking to escape future adversity by migrating to American plants. The German Government sees its last grasp on this important industry being broken by this movement and has ordered the frontiers guarded and all suspected emigrant dye chemists arrested. Dr. OTTO RUNGER and Dr. JOSEPH FLACHSLANDER, however, got out of Germany and into the United States and are now working for the du Pont company. Shall these men be censured for disloyalty to the discredited German system of which they have been a part in the past, or shall they be allowed to make this their country? They cannot go back to Germany and re-enter the fold. They must make good here. To do so they must not be denied any reasonable opportunity nor be hampered by feelings of individual hostility on our part. Nor is American industry to be denied the opportunity to build for the future by the aid of individuals who, through changing economic and industrial conditions in Europe, choose to seek more attractive fields of endeavor. There are many such among us already.

In this matter of anti-German thought what we need most to keep in mind is the hazard of Germans together in large groups. Individual Germans are just like other people; German-born Americans are among the best of Americans. In a few years we hope that the danger of Germans in groups will be over. Suppose 100 German chemists were *bidden* to come here, and as a body to settle themselves in our industries. Singly they would probably be all right, and in time become useful citizens. But jointly, if they were inspired or instructed with the idea that their main business was for *das Vaterland*, that while engaged here in good faith they would secretly address themselves to the advancement of *deutsche Industrie*, then the suspicion might well arise that neither the truth nor the comity of men nor decency nor even honor itself would have weight with them. We don't want Germans "planted" in groups in this country, but if German individuals choose to recognize a new order of things and cast their lot with us they should have an opportunity to show their good faith. As for their being a menace to American industry, we may confidently leave it to our big companies to protect their own interests and those of the country.

How Much Conceit Is Beneficial?

WHEN a young man finishes college and begins work in earnest, he finds himself the object of an indirect campaign to "take the conceit out of him." His elders and business associates see to it that he gets only such work and consideration as will show him how small he is in the scheme of things. If he doesn't have good luck and get promoted within a reasonable time, he is likely to feel downcast and to be glad to cling to the industrial machine by any kind of insignificant job. Especially if he has the temerity to marry within a year or two after finishing college and before he has established himself, he loses his conceit almost entirely and becomes as meek as any employer could wish.

The question is, Should young men be bullied out of their conceit? WHITING WILLIAMS, author of "What's on the Worker's Mind?" thinks that conceit is what makes complicated and highly specialized industry possible, and he advocates that employers encourage their men to feel their individual "worth-while-ness." He explains that the mechanic comes regularly to his bench and the millionaire to his desk, and make sincere, valuable citizens because each feels that he is an important part of the industrial fabric. Each one, though he has grievances and further ambitions, is proud of what he has achieved and can do, and this pride brings him daily to his work and adds zest to what otherwise would be drudgery. As an experienced personnel-manager, Mr. WILLIAMS suggests that this self-pride or individual conceit is the very basis of the social system. Labor unrest comes rather from the neglect of employers to permit their men this incentive than from differences about wages and salaries, says Mr. WILLIAMS. There are more foremen and officials who take unnecessary joy out of life than there should be for healthy conditions, is the conclusion of his book, written after seven months spent working as a common laborer in overalls. In other words, too many of the wrong kind of bosses have been promoted, and their driving, narrow ways have brought resentment. Common laborers, as well as young engineering graduates, have been given too little opportunity to feel the sense of individual worth-whileness that Mr. WILLIAMS recommends. After all, as so many philosophers from PLATO to HERBERT SPENCER

have pointed out, each individual is the center of his own world. Everything revolves around the ego, in spite of temporary campaigns to discredit individualism. The most important thing to each man is himself. When he feels moderately happy, great accomplishments are possible; when he is browbeaten and depressed, he is a force for evil in the world.

The nation which has most encouraged individualism is England. Just as an example, a letter to the London *Times* generally receives respectful consideration both from the editor and from a wide circle of readers; they have learned that excellent suggestions are made in that way, that national benefits accrue from permitting individuals to express themselves, as the canny ADAM SMITH long ago pointed out. In spite of the hamperings of class distinctions in British society, individual genius is probably more quickly recognized than in America. Those in control of things there are influenced by a tradition to help original thinkers who appear to possess talent of value to the nation.

In America there is, of course, what is called "rampant individualism," but it results in everyone being so busy with his own affairs or so shortsighted in his own troubles that the young man of exceptional talent is as likely to remain unrecognized as not. Why was it, for instance, that HERBERT HOOVER found more scope for his extraordinary ability in London than in America, at least until he was a well-known and successful engineer? Without doubt, if he had been a more conventional type he would have found plenty of opportunities in this country, but because his combination of gifts was of the kind that the ordinary American employer did not recognize, he found more attractive openings in British firms directed from London.

Taking a historical case, the record of BENJAMIN THOMPSON, who died over a century ago, shows that that notable scientist and administrator found instant recognition and encouragement in Europe, where he was made Sir BENJAMIN THOMPSON in England and Count RUMFORD in Bavaria. In America, although he was of an old New England family, he encountered only enmity and jealousy. It is true that he left his fortune to Harvard College, but most of his work benefited Europe, since he founded the Royal Institution in London and has a statue to his honor in Munich. It was a pity that America did not profit more by his unusual talents in both pure and applied science—such as his researches in the physics of heat and his experiments with explosives.

These are not the only Americans who have found greater success abroad than was possible in their own country. Many others could be mentioned, and many more who never had the chance to try their fortunes abroad undoubtedly would have succeeded better there than here. In other words, Europe is quicker to recognize certain kinds of talent than is America, not only in literature and art—as is commonly admitted—but also in engineering and general science. America is quicker than Europe to help certain other kinds of ability; we all know of immigrants who have amassed a fortune in short order. But the point is that it is more important to recognize ability among native Americans, such as HOOVER and THOMPSON, than to make the fortunes of Italian or Russian immigrants. The good that a great constructive thinker or critic can do is more essential to the nation than is the operation of the corner fruitstand or the business of a get-rich-quick Ponzi. America's first consideration should be encouragement for her own young men to express themselves in ways helpful to national interest.

That young men are conceited is an excellent sign. Instead of bullying them into forgetting their ambitions, the men in control of industry should take youth more seriously and train it more broadly and more sympathetically, granting opportunities that appeal to the adventurous and eager. In Germany, before 1917, visitors remarked that when the Kaiser or his generals passed down the street, people literally held their breath. That was conceit grown unhealthy beyond all reason, but the moderate conceit that Mr. WILLIAMS advocates is healthy and beneficial.

Metallurgical Mysteries

FEW are so dull who are not at some time or other impressed with the mysterious things with which they work and the mysterious changes taking place under their guidance. In olden days, more simple minds were often overpowered by the strange and unexplainable on all sides, and saw at times the hand of Deity. Today, we more sophisticated talk about the size of the stellar system and the energy in a radium atom just as though the infinite were conceived by finite minds.

But fancy how dull and uninteresting things would be if everything was known about them—the precise facts of their constitution and the exact action under all conditions. Metallurgy may be and doubtless is dull and uninteresting to many who know hardly how to pronounce the word, but how dull it would be even to those who know most about the art if all the mysteries were solved! Real mysteries, not those pseudo-mysteries which one often meets. Such as a locked door which conceals some trade secret—more often than not a process known to many and discarded by them years ago for a better. The fence erected to keep out inquiry too often coops self-sufficiency and ignorance. Or such another myth as "body" in steel—that indefinable something which makes an octagon bar labeled in gilt better than a round one stamped in black.

Granting that the limit of human achievement is merely to push a little farther back the boundary between the known and the unknown and that there will always remain a vast residue of darkness, still it is surprising at times to take stock and find that every branch of metallurgy practices daily large-scale operations about which our precise information is pitifully small. Why do heavy mineral particles float in a Callow cell? In what way are metals entangled in slag and never recovered? Why should humidity play such an important part in the electrical precipitation of fume? What is the nature of the forces acting between white-hot metal and gas, forces underlying all steel-making processes? What is the nature of hardening or of season cracking?

Of course such problems are highly complex. A tremendous amount of work has already been spent upon them, and still there is no conclusion. Their final solution will probably call forth scientific knowledge and resources of high order. But there are many problems somewhat simpler which can be attacked with more modest equipment. As instances: Why does a copper plate prevent case carburization; is it because the thin covering is impervious to carbon monoxide, or is copper

more active than iron in extracting carbon from that gas, so that there is little left for the iron underneath? Why does cupola-melted white cast-iron require a higher annealing temperature than the same metal melted in an air-furance; is it because of higher sulphur or finer grain? Why should either affect graphitization? Why does quenched silicomanganese steel made in the open-hearth require a draw 100 deg. higher for equal hardness than metal of the same analysis from the electric furnace? It it due to extra nitrogen in open-hearth steel; is it due to strange carbides formed in local hot-spots under the electric arc; or is it merely due to the better separation of laminar pearlite usually found in such electric steels?

One might proceed to enumerate many such problems, all of intense importance from a commercial viewpoint. Some of them are under active investigation, such as sulphur and phosphorus limits in tonnage steels, brittleness of steel at a blue heat, and the relationship between fatigue and other physical tests. Others deserve closer attention than apparently they are getting. Why should the common alloy steels acquire "temper brittleness" if slowly cooled after drawing? Why should quenched mild carbon steels after drawing at 400 deg. C. give maximum strength, hardness and solubility in acids? The latter fact has been long known and associated with a peculiar microscopic appearance sometimes called "Osmondite," yet the phenomena do not occur in higher carbon steels. Silicon, phosphorus and aluminum all increase the grain size in steel castings. If a sound, but used, spring be given a heat-treatment similar to that which it originally received, its subsequent life is greatly shortened. Why?

Perchance some who read these lines will attack one of these problems in a systematic way. They will then find a new interest in their workaday life.

Byproduct Coking Establishes Another Record

IN 1920 the byproduct coke production of the United States was approximately 30,700,000 net tons. This is an increase of 22 per cent above the output of the previous calendar year, the result of many influences, among others the fact that 850 new ovens were put into operation during the year. Not only was the quantity of byproduct coke greater than ever before, but also the percentage of the coke output produced in byproduct ovens increased to practically 60 per cent of all, only 40 and a fraction per cent being made in beehive ovens.

Whether 1921 will show a continued increase in coke tonnage or not will depend upon many economic factors beyond the ken or even the guess of the most learned prophets. However, it is safe to say that the percentage of coke made in beehive ovens will for some time continue to decrease. Indeed, it is to be hoped that a decidedly lower percentage will be made by this process each year until we can say that the beehive oven is only a negligible factor in the situation. Simultaneously, of course, the byproduct oven output will increase in both quantity and percentage.

It is too much to ask that all fuel be processed, for if all our bituminous coal could be treated in coke ovens, which it cannot, there would be no adequate market for many of the byproducts. We could, of course, use all of the light oil as motor fuel; in time we might absorb all of the tar as a Diesel engine fuel or as a petroleum substitute; and too, the market for nitrogen would care for all of the ammonia produced (presumably to the exclusion of Chilean nitrate) if the fertilizer demands were carried to the limits proposed by experts in soil improvement. However, the economic conditions permitting such tremendous developments would not justify the necessary large investment in coal-processing equipment. It is well to bear this fact in mind and not be rushed off our feet by the theoretical advantages which can be so glibly recited in favor of coking on a large scale.

Reasonable encouragement should be given to the coking of coal, so that the market for byproducts may be amply supplied and inducement offered for the maximum utilization of these valuable chemical raw materials. In the meantime, however, it should be clearly recognized that the development will be gradual rather than spectacular. And through it all there should be a progress from year to year that will be most encouraging to both byproduct producers and to the industries using their products as raw materials.

Brains Applied To Forging

DETAILS of a hundred kinds impress one with the herculean efforts France made seven years ago to stop the German attack. Once stopped, and taking stock of her resources, she found the enemy in possession of 70 per cent of her metallurgical works. This at the very outset of a war, won undoubtedly by human courage and sacrifice, but nevertheless a war between special engines and machines of great power and wide variety!

That eminent French ironmaster EUGENE SCHNEIDER has recently made several allusions to the progress, construction and intensive production which was necessary in order that their troops could be properly supplied with munitions. In his presidential address before the 1918 meeting of the British Iron and Steel Institute he alludes to the startling savings made possible by every attention being given to eliminate unnecessary delays in fabrication. "Two compressed-steel ingots, weighing respectively twenty-one tons, were selected, as they came from the molds, to be forged into three 220-mm. Schneider mortars and one 155-mm. Schneider howitzer. Particular attention was bestowed on the former through all forging operations; the latter was left to the current routine of the gun shop. Now, whereas it took eleven and one-half days and seven heatings, plus one of annealing, to transform the former, for the latter forty-three days and nine successive heatings, plus one of annealing, were necessary. The expenditure in fuel was, therefore, more considerable for the latter, but especially there was ample scope for the elimination of the so-called dead stops."

With three-quarters of the plants gone, France of course strained every effort to construct new and modern works far to the rear of the battle zones; but waiting their completion, a close attention to operating details was evidently able to increase the apparent capacity enormously.

While he does not say as much in so many words, undoubtedly the recorder he described last fall, and briefly noted in this issue, was of great help in such a remarkable saving in time. It is a happy augury that tradition, which excludes sunlight from a forge shop, has been unable to prevent the entrance of common sense.

Readers' Views and Comments

Shall Chemists Be Registered, Certified and Legalized?

To the Editor of Chemical & Metallurgical Engineering

SIR:—Referring to your editorial, "A Question That Will Not Down," in your issue for Feb. 2, I think that the views there expressed are very much to the point, and I agree with you that the scheme of listing and certifying chemists had best be tried out first in New Jersey. I question whether it is really necessary to start a new organization such as the proposed Institute of Chemistry. Could not the matter be handled by one of the existing chemical societies, either the American Institute of Chemical Engineers or the American Chemical Society? That new, live organization, the New Jersey Chemical Society, is most earnestly interested in the question, and undoubtedly can do much by trying out the idea in its own state.

The main issue, as I see it, is not only "Who is a chemist?" but "How to tell the general public who is a chemist." Members of the chemical and allied professions and industries employing chemists need no Institute of Chemistry to recommend men to them or tell them where to procure certain materials. The general public, on the other hand, have a very vague idea as to how to proceed. Their only source of information is the daily press and the *Saturday Evening Post*. Probably they have never heard of our chemical journals nor of the Chemical Catalog nor of that handy little annual published by Williams & Wilkins of Baltimore.

My suggestion is to have the New Jersey Chemical Society do some advertising. This may bring forth adverse criticism on the ground that it is unethical for a scientific organization to advertise. Nevertheless, if the advertising be done discreetly, the objections will easily be overruled. The society might insert a small notice in the Newark *News* throughout the year informing the readers that anything pertaining to chemicals or chemists can readily be ascertained through the society.

South Yonkers, N. Y. COLIN D. FINK.

Should Start Within American Chemical Society

To the Editor of Chemical & Metallurgical Engineering

SIR:—Referring to your editorial on the proposal of the New Jersey Chemical Society to organize an American Institute of Chemistry, I wish to say that I have already had some correspondence with the promoters of this plan and have strongly advised the desirability of not attempting to have the tail wag the dog, but to get the dog to wag the tail. In other words, a small society should not take upon itself the burden of starting a big institution which it would be difficult for even the American Chemical Society to start. I think it would be far better if the movement should start from the parent society and not from one of the smaller organizations, because the men of reputation in the country will hardly like to go into an august body, such as this would be, through the back door.

The origin of the Institute of Chemistry of Great Britain is along much the same line as the plan which has been proposed recently in this country. A certain section of the Chemical Society in London was under the impression that the highbrow stuff read and published by the Chemical Society was not exactly what was needed for a consulting chemist. Several of the latter tried to get the Chemical Society to form a section through which consulting men could be known to the country as experts in certain lines. The highbrows in the Chemical Society said that any man belonging to it was guaranteed as being the finest man in his profession, to which the others replied that all that was necessary to belong to the Chemical Society was to get three members to sign a paper, and pay one's dues yearly, which any office boy could do. As a consequence a few of them got together between thirty and forty years ago and formed the nucleus of the Institute of Chemistry of Great Britain, and after they had been in existence for a time they managed to obtain a Royal Charter, which gave them power similar to that exercised by the universities—in a measure to grant a degree, which was given only after an examination. The self-appointed nucleus of this organization, being men of reputation and in most instances well known to the country at large, exercised great care and diligence that no office boy or similar person was admitted during their organization of the society. When the Royal Charter was granted all free admissions were stopped, and entrance was obtained by examination only, a practice which obtains to the present day.

The objects of this society were to raise the standards of the consulting man and generally see to the ethics of the profession; and I think I am not wrong in saying that any Fellow of the Institute of Chemistry of Great Britain is an exceedingly high-class man and can always be relied upon in any class of work which he undertakes. Should he get into work for which he is not quite competent, all he has to do is to go to one of the other Fellows who stand always ready to help him. All chemical offices of a public nature in Great Britain can be obtained only by Fellows of the Institute of Chemistry. Only in very rare instances are chemical posts given to other men, and during the war this was very much accentuated.

You will remember there was a similar movement on foot here some years ago, but instead of starting with the parent society, the American Chemical Society, a certain few broke away and started the American Institute of Chemical Engineers. I do not think that the chemical engineers are the right people to have charge of such a movement as the New Jersey Chemical Society proposes, nor do I think that the New Jersey society itself is the right place to start it. It should be done within the body of the American Chemical Society and certain selected men within that body should be formed into a section of consulting chemists, which would raise the standards of that class of chemists and would after a time institute an examination whereby only those fitted could become members. There would be a very great advantage in having such a society as this, because at the present time it is almost impossible to recommend a suitable man to a client, unless one happens to be

personally familiar with the records of a large number of men. In any event, there is no official record, and one has to trust to memory and hearsay, as to what this or the other man does or is competent to do.

A FELLOW OF THE INSTITUTE OF CHEMISTRY
New York City. OF GREAT BRITAIN.

Register, Perhaps Certify, But Not Legalize

To the Editor of Chemical & Metallurgical Engineering

SIR:—Referring to the proposal to form an Institute of Chemistry, I feel that the American Chemical Society now possesses a very good list of all the chemists in the country, though I am sorry to say that it contains the names of some who do not stand high. I would like to see the American Chemical Society's membership revised into chemists and associates, and have the former picked by a good committee. This would cover the first two points proposed in the scheme of the New Jersey Chemical Society—namely, listing and registering. As for certifying, this also might be worked in.

In the matter of legalizing, however, I am not sympathetic. I know that plumbers are legalized, but plumbers are robbers; doctors are legalized, but their patients pay for their mistakes; undertakers are legalized, but they bury the mistakes of the doctors. I believe that chemists should be able to demonstrate a high standing to such an extent that they will not need any legalizing.

New York City. DAVID WESSON.

Need for Complete and Classified List

To the Editor of Chemical & Metallurgical Engineering

SIR:—Referring to your editorial on the proposal to form an Institute of Chemistry, I am inclined to agree with your opinion. I think, however, that the plan has several good points, and suggest that Dr. Crane talk to the Council of the American Chemical Society about them.

While in Washington during the war, my work brought me in contact with chemists all over the country, and at that time an alphabetical list was made of all chemists in the service as well as out of it. I had hoped that this index might be kept up, and by combining it with the data secured by Major Breithut and the records held by Dr. Parsons, it would have been a comparatively easy matter to make a complete list of all chemists in the country and classify them according to their qualifications. I should like to see something of this kind carried out, as I believe it would be of great benefit to American chemical industries.

Brooklyn, N. Y. ALLEN ROGERS.

Certification a Difficult Problem

To the Editor of Chemical & Metallurgical Engineering

SIR:—Replying to your recent letter regarding the advisability of organizing an American Institute of Chemistry, I would reply that the subject is a complicated and difficult one to handle. The New York Section of the American Chemical Society was troubled with the same problem about fifteen years ago, and after considerable study and discussion of the question decided that it would be inadvisable to attempt anything of the kind at that time. Of course, it does not necessarily follow that it is therefore inadvisable at the present time.

Superficially, the question appears to fall naturally into two main problems: (1) Registration; (2) certification. For purposes of registration, the proper place, in my opinion, is the office of the secretary of the American Chemical Society, where there are already available the results of the extensive census of American chemists conducted by the Bureau of Mines during the war. In addition there is all of the material collected by the Chemical Warfare Service. The secretary's office could without very heavy financial expense function as the repository of the biographical records of all such chemists as may be willing to supply the requisite information concerning themselves.

The problem of certification is much more difficult and one which I do not feel the American Chemical Society can safely undertake without danger of disrupting its organization. The great success of our society has been due to its simple democracy, there being no distinctions of any kind attempted between the various groups of members. In years gone by such discrimination was attempted and we had active and associate members. The result was very unsatisfactory and as soon as this discrimination was dropped the society began to go forward by leaps and bounds, until it has reached its present proud position of being the largest chemical society in existence.

To undertake the creation of an Institute of Chemistry, presumably modeled along lines similar to those of the Institute of Chemistry of Great Britain, is a serious undertaking, and we must be clear in our own minds that the situation justifies it.

New York City. MARSTON T. BOGERT.

Would Advertise Profession of Chemistry for Public's Education

To the Editor of Chemical & Metallurgical Engineering

SIR:—Referring to your editorial on "Who Is a Chemist?" in which you comment on the proposal of the New Jersey Chemical Society to found an American Institute of Chemistry, I wish to say that a good many years ago I was chairman of a committee of the American Chemical Society which considered this same question and reported that in its opinion it was undesirable either to license a chemist or to form an Institute of Chemistry such as existed in England. The committee was of the opinion, however, that it would be desirable for the American Chemical Society to set up a branch of its membership which should take the place of an Institute of Chemistry and perform such functions of the British Institute as were practicable and desirable in this country.

Bearing on this subject, I have recently written to Dr. Crane of the New Jersey Chemical Society substantially as follows:

The first question one naturally asks about this matter of forming an Institute of Chemistry or of licensing chemists is, What is it designed to accomplish and what needs would such a movement fulfill? The answer seems to be that today there is nothing to prevent any man, whether he is wise or ignorant, able chemist or charlatan, from hanging out his shingle and advertising himself as a chemist. At the same time, before a man can practice either law or medicine he must have attained a fairly high standard and must have been legally recognized. Furthermore, even plumbers and chauffeurs must prove their fitness to act in their respective capacities, or otherwise we should be poisoned with sewer gas or constantly threatened with loss of life on our streets. The real question is whether the employment of a chemist involves risks to the employer that are comparable to those taken by the public in employing a

lawyer, physician or chauffeur, and furthermore, whether these risks can be removed or greatly minimized by examining chemists and thus separating the sheep from the goats.

The relation of the chemist to the public is now such a complex one, and the services now rendered by chemists and to be rendered in the very near future are so varied in character, that it is difficult to see how any examination could cover the field. If it did so adequately, few could begin to pass it, and probably the few who could do so would be by no means the best men.

So much for legislative regulation as to the fitness of chemists to practice their profession at all. The plan of forming an Institute of Chemistry which shall guarantee only that its members have in the first place an extensive knowledge of general theoretical chemistry, and, if it seems desirable, also guarantee that certain classes of its members are expert in this or that branch of chemical practice, rests upon an entirely different and surer footing as long as it does not attempt to make a closed shop of the country and deny to non-members the right to work if they can find employers. The serious difficulty between the chemists and the public today is the lack of understanding by the public of the nature of the services which the chemist can render. Restrictive legislation does not promise anything like a remedy for this, but the American Chemical Society already is doing much, and perhaps an Institute of Chemistry, if it should undertake this task, might accomplish more. The question seems to resolve itself into one of properly advertising the profession of chemistry, letting the public choose who serves it best. It is only the chemists who can teach the public that their services are necessary and valuable, and the plans outlined by the New Jersey Chemical Society may be judged by the test of whether or not they are to further this teaching.

New York City. PARKER C. MCILHINEY.

Plan Should Be Tried on a Small Scale at First

To the Editor of Chemical & Metallurgical Engineering

SIR:—Referring to your editorial on "Who Is a Chemist?" and the proposal of the New Jersey Chemical Society to start an American Institute of Chemistry, I wish to say that such an institute if started should have a small geographical scope. An organization covering the State of New Jersey probably will be large enough; perhaps a county or a few counties will be big enough for a beginning. In other words, I favor a kind of test-tube experiment first. Conditions vary so from city to city and state to state that I am convinced that the inauguration of a national body in the beginning would fail and unnecessarily delay national standardization far beyond the time at which it can be accomplished if started in small units in different states or localities. Let the New Jersey Chemical Society try to standardize things for, say, the Newark district and then spread out from there. This process would bring to light a lot of concrete facts that would help solve the national problem.

As for some of the other things which it is proposed to accomplish, why not assist the present agencies to do them better, rather than inaugurate something new? Thus in the proposal to list all chemical products, why not help out the Condensed Chemical Dictionary? And as for listing all chemical industries, why not help Dr. Lovelace keep the Annual Chemical Directory up to date and properly enlarged instead of competing with him? It seems to me that the New Jersey Chemical Society could contribute a great deal to the subject by outlining in the form of a law the necessary requirements for the general or specific practice of chemistry. Here again they might begin with a small district, such as Newark, and then try it for the State of New Jersey and see if the state will pass such a law.

New York City. BERNHARD C. HESSE.

Futility of Examinations

To the Editor of Chemical & Metallurgical Engineering

SIR:—In your editorial, "A Question That Will Not Down," in the Feb. 2 number, the sentence, "As for the certification feature . . ." brings up a very vital question, Who is really competent to judge the correctness of answers to questions dealing with industrial subjects? We have many men in the chemical, as well as in other sciences, with advanced ideas, which are not common property. A set of examination questions can easily (and quite unintentionally) ask for such knowledge, which the candidate has made a special study. If he answers to the best of his ability, he would be publishing information which others have been seeking unsuccessfully. If his answers are only on the basis of published information, they may be considered insufficient due to special knowledge by one or more of the examining board. Furthermore, technical questions are often a matter of opinion due to varying conditions. What is excellent practice at one point, due to conditions, must be condemned elsewhere.

Another phase of this question is how such an examination would be conducted. Would the candidate be compelled to rely solely on what he carries in his head or would his knowledge of where to find information also be considered? This latter source of knowledge is often much more valuable than the former, otherwise we would have very limited use for reference libraries. A recent advertisement for an experienced industrial manufacturing chemist at $80 to $100 per week specifying "Must pass preliminary examination without reference to handbooks" certainly expresses the opinion that only memory of facts, and not the ability to find facts, is knowledge.

Are we not treading on very thin ice?

Newark, N. J. HERMAN S. RIEDERER.

Causes of Corrosion of Copper and Brass

At a recent meeting of the Birmingham and Midland Section of the Society of Chemical Industry, Dr. O. F. Hudson, of the Admiralty Research Laboratory, said that he believed electrochemical action was not the sole cause of corrosion in the case of copper and brass, and that in most cases, in neutral or slightly alkaline solutions, that action was relatively unimportant, the greater part of corrosive attack in these cases being due to direct chemical action. In acid liquids, and industrial waters which had a distinctly acid reaction, electrochemical action might play a more important part, but in such cases the metal—e.g., condenser tubes—failed by general thinning rather than by pitting or localized attack, which was in other cases generally the chief trouble. Electrolytic protection processes probably owed their efficiency largely to the production and maintenance of a uniform resistant scale of calcium carbonate. There was little hope of finding an alloy which would resist corrosion under all conditions.—*The Engineer*, Dec. 17, 1920.

What Chemistry Can Do in the Food Industry

A Concise Dissertation on the Broad Field of Work That Is Open to the Chemist in the Food Industry and on the Beneficent Results Derived From the Application of Chemistry to Obtain More, Better and Cheaper Food

By R. S. HILTNER*

IN THE industry of food production, nature and science have always been true helpmeets and must necessarily be such. Since 1912 the knowledge of food and of the essential principles of animal feeding and nutrition has been marvelously clarified. Such competent investigators as Funk, McCollum, Osborne, Mendel and many others (Seidell, Morse, Talbot, Hogan) have turned a deep-penetrating searching light on the subject and have discerned many facts as to the true nature of food and the dietary requirements of the animal body. Those men and others not mentioned have shown by their discovery and study of vitamines, food accessories, that in reckoning the feeding value of food we must consider more than the mere calorific coefficients and the empirical composition, the percentages of fats, carbohydrates, protein and mineral salts. They have shown that certain natural foods—eggs, milk, green vegetables, mature fruits, for example—contain substances that are absolutely essential to growth of the animal body—dumb brute or human. Without those substances the body would soon become scurvied, would wither and die, even though fed with fat and protein and sugars and inorganic salts.

They have shown that those classes of food components, though closely approximating each other in chemical composition, differ widely in their nourishing powers. We know now that all proteins are not alike in nutrient quality and digestibility. The fats and oils, while similar in their proportions of carbon, hydrogen and oxygen and in their heat values, vary widely in flavor, palatability and assimilability. Even the carbohydrates are not in agreement as to food value. The starches differ from the hydrolized bodies, and, what is more, the sugars having identical empirical composition are variable in value as foods. The aldehyde sugars—for example, dextrose—are not like the ketone sugars, such as levulose, in food quality. Recently it has been shown that the starches of various plants are dissimilar in chemical composition, and by inference we may conclude also that they are not quite alike in food value. We have been wont to believe that starch is starch—a carbohydrate strictly so. But starches contain phosphorus largely in carbohydrate combination[1] and in varying amounts. Potato starch contains about 0.15 per cent total phosphorus computed as P_2O_5, while corn starch contains only 0.03 per cent.[2] Obviously, therefore, the sugars produced from the different starches by hydrolysis have somewhat un-uniform composition and probably variable nutritive value.

These facts—some newly discovered and some long known—possibly somewhat unrelated to the subjects are set forth here as a framework for the answer to the question, What can the chemist or chemistry do in the food industry? The activity of the chemist in the food industry naturally resolves itself into three or more phases. Analytical control is one, technical and engineering another, and investigation and research another. All are important and it is difficult to say which is the most essential to progress and success of the industry. The analyst's part in the industry is easily understood. It is important work. The chemist-analyst is the controller of the industry. He holds forth the guiding hand. The function too of the chemical engineer is clearly defined. We look to him for results in matters of production and quality of output and for constructive suggestions relating to improvemnts in technique and general procedure.

What the chemist investigator can do to benefit the industry is quite another matter. It is the kernel of the inquiry. When we speak of the food industry we quite intuitively think of food manufacturing. But, strictly speaking, is there such a thing as food manufacturing or can there be? Do not the electricians' terms "transformer" and "transforming" apply more aptly? No one has ever made a fat or an oil, though the chemist has learned how to transform them and refine them and make palatable food-fats out of unpromising products. No one has ever manufactured a protein or a starch. Nature's barrage has been so dense and so baffling in this respect that few, in recent years, have had the courage to attempt to penetrate it. The production of the fundamental food elements seems to require nature's own handiwork. No true-hearted chemist should ever allow himself to cry "it can't be done," or permit himself to be checkmated, or to throw up his hands and quit while the breath of life remains in him. But thus far the "game" has been practically lost by all who have played it. The nearest approach to winning against natural forces—and this may be said for the encouragement of the chemists who will still try—is in the synthesis of a few of the sugars and of some of the organic food-acids. Despite all the efforts that have been made we are forced back into the groove of thought of chemists prior to Wöhler and are thinking and saying that nature does and must play an important part in the production of "organic" chemicals. As a matter of fact, and strictly speaking, all foodstuffs are "organic" chemicals, simple or complex compounds or mixtures. Salt is perhaps the only exception, though it is not really food. The ash, frequently spoken of as "mineral matter," derived from foods by incineration, does not exist in foods, *per se*, but in combination with organic acids, protein, etc.

The discoveries of vitamines by biological chemists recently have also served to upset the calculations of many an ambitious chemist who would produce foods

*National Canners' Association, Denver, Col.

[1] Northrop and Nelson, *J. Am. Chem. Soc.*, vol. 38, p. 472, February, 1916.

[2] R. S. Hiltner, National Canners' Assn., and H. J. Wichmann, U. S. Dept. of Agriculture, Bureau of Chemistry; unpublished article.

artificially and synthetically and even of the less scientific and pretentious food manufacturer or transformer, if you please, who would elaborate some strange raw product into acceptable food.

Natural Foods Versus Chemically Made Foods

The proof recently secured that butter fat is far superior as growth-producing food to other oils and fats is as interesting and valuable as it is disconcerting to the chemist. Who can say at present that those acids and those sugars that have been produced artificially are as good foods as those elaborated by nature? The presence of food accessories, minute in amount but mighty in force and effect, in natural foods still keeps them at a high premium above any that chemistry has elaborated. Perhaps after all it is just as well that it should be so. The kitchen is not the normal place for the chemist. Trained appetite will not willingly open its mouth for chemical food. The layman in his mind associates chemicals with poisonous acids and vile smells and wants none of them for food. God-made foods are to be preferred to man-made.

The Scope of the Chemist in the Food Industry Is for Greater Efficiency

If, then, the chemist yield to the thralldom of Nature and admit that she is the supreme artisan and compounder of food, what is there left to him as a scientist to accomplish in the food industry? The most sensible answer seems to be that he continue his course, outward and upward, working out his schedule, striving for greater and greater efficiency. That course has never been along the smooth road marked with signposts, but off the trail into regions unexplored. His schedule in the food industry has never comprised, as an essential part, the fanciful plan of elemental construction of foods, but rather the scheme of refining natural products and finishing raw materials. Extracting foods rather than manufacturing them has been the accomplishment of chemistry.

The refining of sugar from the sugar beet and the recovery of byproducts is one of the most notable achievements of chemistry, as applied to foods production. Out of raw juice of the beet, complex in its make-up, by the use of simple and inexpensive reagents a food is recovered practically chemically pure. There is a splendid example of food chemist efficiency. Therein lies a suggestion for further work. The human appetite craves sugars; the animal body requires them. They must be extracted from raw products or else built up from other products. Substitutes there are none and can be none, any more than there can be real substitutes for butter, for eggs, or for the protein of meat. The tongue may be fooled, but the stomach never.

The demand for sugar is ever increasing. To meet it the sugar chemist should do his part. Increased production will come from closer communion and co-operation with Nature on the part of the chemist, the plant-breeder and the farmer. The scientist in the laboratory and the scientist on the farm must keep in touch. The two must study and develop species of plants now unused for sugar production. They must not overlook the starchy roots that can be converted into sugars—the "cat-tails" and sweetflag of the roadside bog may be cited, in passing. They must not forget the possibilities in other roots and tubers. The Jerusalem artichoke, the dahlia bulb, the chicory root contain inulin, kindred to starch, capable of yielding a sugar, levulose, sweeter far than glucose.

He who takes the lead in these matters must be possessed of a fine courage, must let his fancy take flight, must be willing to risk well-earned reputation, must "take a chance." The sugar chemist must study deeper into mysteries of carbohydrates. He must know cellulose better. That stubborn substance, the framework of plants, itself a corbohydrate closely related to starch and sugar, should be converted or transformed into sugar. Speed the day when a sack of sugar can be evolved from a bale of straw! Progress along this line has been made recently in the U. S. Forest Products Laboratory at Madison, Wis.[3]

What the Chemist Can Do in the Food Industry

The animal continually clamors for food. In the words of the nursery jingle, "Please give us more and more and more, such hungry birds I never saw." It is not the cry of greed, but the call of need. Chemistry more than any other science can aid in supplying that demand, especially so far as human food is concerned. The ox relishes raw cane, but man must have refined sugar; the wild animal prefers the blood and vital organs of his prey, but man chooses "dressed" meat.

The sugar chemist has a part to play in meeting that requirement; the oil chemist a part and the protein chemist a practical rôle. Many problems are yet unsolved and there is room for each to do his best.

Someone will soon learn how to make better glucose—a drier, whiter, sweeter product from starch. Someone will improve the present sugar and recover more from the raw material. Someone will develop a better process for gelatine and produce a cleaner, more wholesome article. Someone will make still further advances in transforming and refining edible oils, and make more oils fit to eat.

Chemists are learning more and more about catalysts and enzymes and ferments and will use them more in the future in producing new foods or better products.

Some day chemistry will discover the way of extracting vitamines from bulky produce and concentrate them in acceptable forms in foods. Chemistry will improve the art of preserving foods by canning, by drying, by concentrating, holding color and flavor and food quality intact. Paradoxical though it sounds, the chemist will teach us how to transform, preserve and conserve foods without the use or introduction of chemicals. For the dried fruit industry he will discover the way without using sulphur to destroy the enzymes and prepare the product so that the eye of the consumer will be pleased and the palate not offended and health not deranged. For the miller he will find a better means of bleaching and "aging" flour. For the butcher he will learn better technique in preserving meat, avoiding chemicals and dyes. For all he will constantly watch for "leaks" and devise better schemes for preventing wastes and for utilizing byproducts.

These things are not said as prophecy, but because of an abiding confidence in the ability of the chemist to accomplish whatever he diligently seeks to attain. He will answer the call for more and better and cheaper food. In his efforts to achieve these things, let him emulate the aviator, unafraid, striving for altitude records, braving the cold lonesomeness of the higher levels and minding not the withering winds of ridicule.

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[3]See CHEM. & MET. ENG., vol. 24, No. 4, p. 160, Jan. 26, 1921.

Electrolytic Zinc Plant of the Anaconda Copper Mining Co., at Great Falls, Mont.*

Utilization of Sulphate Roast to Save Leaching Acid—Insoluble Zinc Ferrates in Iron-Bearing Calcine—Coagulation, Granulation and Filtration of Silica and Other Impurities From the Zinc Solution—Slime Purification—Dross and Residue Treatment

ABOUT six years ago the Anaconda Copper Mining Co. decided to investigate the possibility of extracting zinc from the complex ores of Butte containing so much iron and lead that the concentrate analyzed only 33 to 35 per cent zinc. After a careful preliminary study it was decided that the electrolysis of sulphate solutions was the most promising method for zinc recovery. It was soon found that to obtain a good zinc deposit an electrolyte is required free from all metals more electronegative than zinc, such as copper, cadmium, lead, arsenic or antimony, etc. Arsenic and antimony are particularly injurious, causing very small yield per horsepower when present in amounts so small as almost to defy detection—1 mg. or less per liter.

It was not found difficult to maintain an extremely high degree of purity in the zinc solution going to the cells if the iron content is thoroughly oxidized before precipitation by means of limestone or excess calcine and if sufficient zinc dust is added to satisfy the copper, cadmium and whatever small amount of lead might be present. It may be necessary to add a ferric salt to low-iron solutions to insure the complete precipitation of all arsenic as ferric arsenate. The best way to make sure of the oxidation of the iron is to maintain a small amount of manganese in solution; it becomes oxidized in the cells to permanganic acid, manganic sulphate and manganese dioxide.

An aluminum plate makes the most successful cathode and a lead plate the most suitable anode. The latter becomes coated with a brown layer of manganese dioxide and lead peroxide, but if the electrolyte is entirely free from chlorides the lead is not attacked; anodes used three years seem as good as new. Zinc starting sheets proved unsatisfactory, as the sheets warped and caused short circuits.

Forty-eight-hour sheets weighing about 20 lb. (40 lb. per cathode) are generally made. Heavier cathode deposits become roughened, due to sprouting, and also tend to break contact between sheet and the aluminum plate.

In practice the most satisfactory current density is from 22 to 25 amp. per sq.ft. Evolution of gas at the anode is then sufficient to provide the necessary agitation.

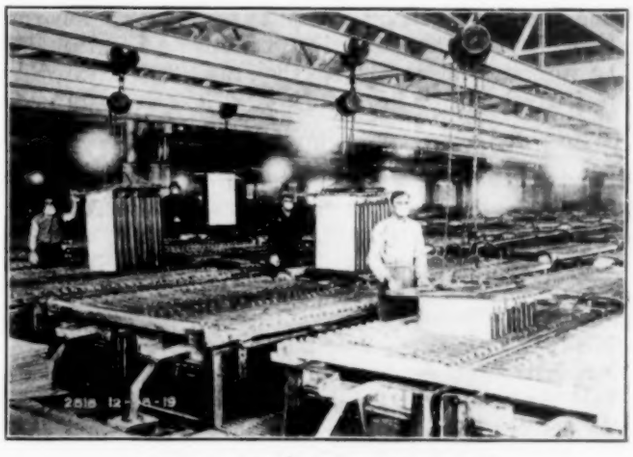
After working in the laboratory for more than twelve months a 10-ton plant was erected at Anaconda, but by making changes its output was increased to twenty-five tons per day. The plant went into commission about the first of November, 1915, and was operated with considerable profit for a year. On Dec. 13, 1915, ground was broken for a 100-ton plant at Great Falls; this plant began operations on Sept. 11, 1916, and was completed in December. In 1918 the plant was enlarged to make 150 tons of zinc per day.

Roasting Division

At Great Falls there are fourteen roasting furnaces of the Anaconda-Wedge type. As the 1918 extension called for more roaster capacity than was available at Great Falls, fourteen 20-ft. McDougall furnaces at Anaconda were converted into zinc roasters. Each furnace has two fireboxes, one on each side of the seventh hearth. Powdered coal is blown into the fireboxes under 12-lb. pressure.

This plant was started on the oxide roast as developed at the Anaconda experimental plant. When the new zinc plant reached full capacity, the sulphuric acid plant at Anaconda was unable to supply the leaching acid, so it was decided to try again sulphate roasting, unsuccessful in the 25-ton plant at Anaconda. As the result of a series of tests, which demonstrated that a sulphate roast was practicable, all furnaces were put on sulphate roasting with a 40-ton feed per twenty-four hours, with results as plotted in Fig. 1. The slower speed of the rabble arms and low temperature resulted in a big reduction in furnace repairs which more than compensated for the slight increase in fuel and for handling the doubled weight of flue dust. Apparently there is a decrease in silver volatilization with sulphate roasting because silver recovery has been higher at Great Falls than at Anaconda.

Much has been said about the difficulty of roasting iron-bearing concentrates, so as to render the zinc soluble. It was found that insoluble zinc compounds are undoubtedly formed and the percentage of zinc that remains insoluble increases with roasting temperature. However, it is not difficult to



ZINC ELECTROLYZING DIVISION
Operation of lifting frames and method of cathode removal

*Abstract of a paper to be presented Feb. 14, 1921, before the N. Y. meeting of the American Institute of Mining and Metallurgical Engineers by Frederick Laist, manager Reduction Works, Anaconda Copper Mining Co.; F. F. Frick, research engineer Anaconda Copper Mining Co.; J. O. Elton, assistant general superintendent Great Falls Reduction Department, Anaconda Copper Mining Co.; R. B. Caples, assistant superintendent Great Falls Reduction Department, Anaconda Copper Mining Co.

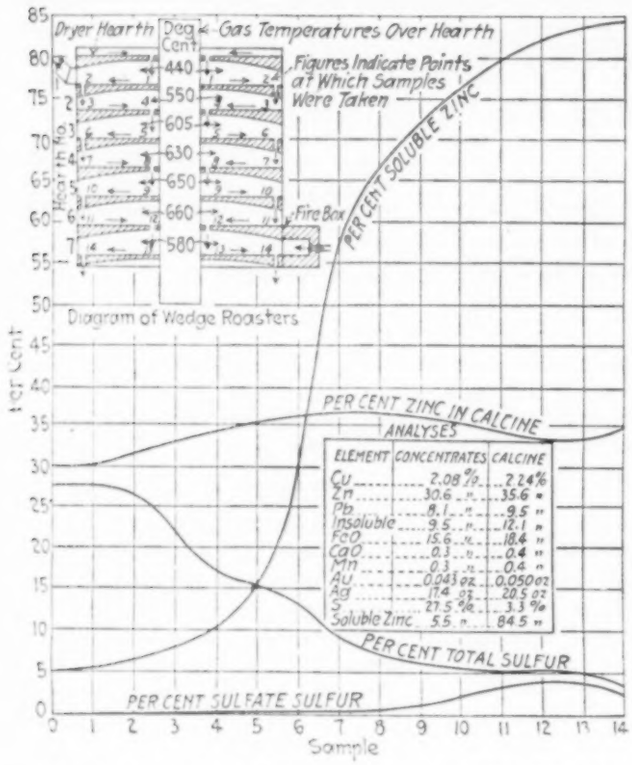

Dryer Hearth
Deg. Cent.
Gas Temperatures Over Hearth
Figures Indicate Points at Which Samples Were Taken
Hearth No.
Fire Box
Diagram of Wedge Roasters
PER CENT SOLUBLE ZINC
PER CENT ZINC IN CALCINE
ANALYSES
ELEMENT CONCENTRATES CALCINE
Cu 2.08 % 2.24 %
Zn 30.6 " 35.6 "
Pb 8.1 " 9.5 "
Insoluble 9.5 " 12.1 "
FeO 15.6 " 18.4 "
CaO 0.3 " 0.4 "
Mn 0.3 " 0.4 "
Au 0.043 oz 0.050 oz
Ag 17.4 oz 20.5 oz
S 27.5 % 3.3 %
Soluble Zinc 5.5 " 84.5 "
PER CENT TOTAL SULFUR
PER CENT SULFATE SULFUR
Per Cent
Sample

FIG. 1. ROASTING LOW-GRADE CONCENTRATES IN WEDGE FURNACE

make a calcine containing 82 per cent of its zinc soluble in 2 per cent sulphuric acid, from a concentrate that contains 33 per cent zinc and 20 per cent iron. An excessive temperature (more than 600 to 625 deg. C.) will reduce the efficiency to 60 per cent. A concentrate containing 50 per cent zinc and under 5 per cent iron will render soluble about 94 per cent of its zinc. (Fig. 2.) The temperature may be greatly increased on low-lead concentrates which do not sinter.

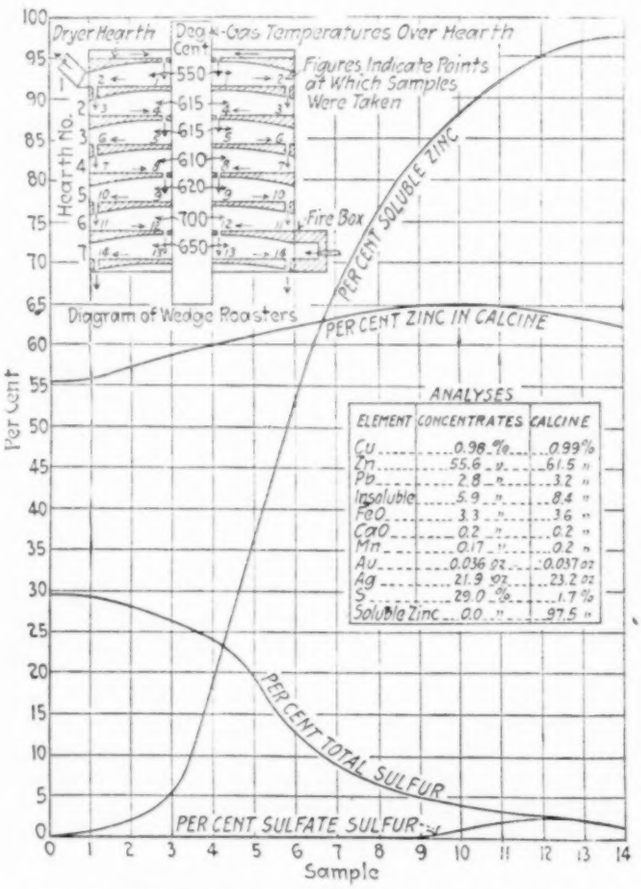
The McDougall furnaces at Anaconda have consistently given about 3 per cent higher solubilities than the larger Wedge furnaces; the former are equipped with dust collectors and have the firebox on the sixth hearth. The Cottrell treater, being placed just over the furnaces, precipitates sulphur trioxide with the flue dust which is returned hot to the first hearth of the furnace when the treater plates are rapped. This sulphur trioxide appears to combine with the moisture of the incoming concentrate, forming sulphuric acid on the first hearth, and producing a fuming effect. This may account for the increase in the amount of soluble zinc, since experiments have shown that soluble zinc in roasted concentrates can be greatly increased if the raw concentrates are moistened with H_2SO_4.

Leaching Division

Leaching is continuous and in two steps: (1) A neutral leach where all the calcine and approximately one-half of the total acid is added; (2) an acid leach where the remainder of the acid is added. Operations may be followed by reference to the flow sheet, Fig. 3. A general plan of the 150-ton leaching building is shown in Fig. 4.

Solution for the neutral leach is made up with one-half the cell-acid (containing 11.5 per cent H_2SO_4 and 7.5 per cent Zn) and the partly spent leach liquor (0.6 per cent H_2SO_4 and 10 per cent Zn) from the acid leach, and run into the first of a series of seven Pachuca tanks. Sufficient oxidized iron must be present to account for all the arsenic and antimony, otherwise they will not be removed and poor tank-room efficiency will result.

Calcine is fed into the next three Pachuca tanks in such manner that there is an average drop of 2.5 per cent acid in each tank. Nothing is added to the fifth tank, which is used as a control tank in which the acid should be nearly, or completely, spent. One-sixth of the total amount of calcine is added to the sixth Pachuca tank, together with a small amount of limestone. The excess base contained in the calcine and limerock completely precipitates the ferric iron, granulates the gelatinous silica and partly precipitates the copper. These chemical precipitates, together with the insoluble residue, carry down all the freshly formed insoluble compounds of arsenic and antimony. The seventh Pachuca is also a control tank. After the base is added it takes several minutes for the leach to coagulate. This is one of the most important steps in the process; if it is carried out too rapidly poor settling results and in a short time the rest of the plant will be blocked with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PER CENT SOLUBLE ZINC
PER CENT ZINC IN CALCINE
ANALYSES
ELEMENT CONCENTRATES CALCINE
Cu 0.98 % 0.99 %
Zn 55.6 " 61.5 "
Pb 2.8 " 3.2 "
Insoluble 5.9 " 8.4 "
FeO 3.3 " 3.6 "
CaO 0.2 " 0.2 "
Mn 0.17 " 0.2 "
Au 0.036 oz 0.037 oz
Ag 21.9 oz 23.2 oz
S 29.0 % 1.7 %
Soluble Zinc 0.0 " 97.5 "
PER CENT TOTAL SULFUR
PER CENT SULFATE SULFUR
Per Cent
Sample

FIG. 2. ROASTING HIGH-GRADE CONCENTRATES IN WEDGE FURNACE

mud. When properly carried out each granular particle appears to be inclosed in a flake of freshly precipitated iron, lime or gelatinous silica. The solid particle forms a nucleus for the precipitate and provides the weight to carry down the flaky particles.

The discharge from the last Pachuca goes to the neutral classifiers, which remove the sand for regrinding and return for further treatment. Overflow goes to Dorr settlers, which discharge a clear liquid for the purification process, and a spigot product (50 per cent solids) for feeding the acid leach.

To sum up, in the first, or neutral, leach all calcine enters the process and approximately three-fourths of the soluble zinc is taken into solution; iron is oxidized and precipitated; gelatinous silica is coagulated by excess base and rendered granular; arsenic and antimony are completely precipitated; 80 per cent of the copper is precipitated as hydroxide by the excess base: a large percentage of the zinc is separated from the residues in a clear solution, containing 20 per cent of the soluble copper and all the soluble cadmium.

The ground sand and the settler spigot are leached in three 10 x 20-ft. Pachucas with the remainder of the cell-acid and sent to the acid settlers. It is necessary only that the overflow is maintained at approximately 0.5 per cent acid. Too high acidity interferes with the settlement on the neutral side, increases the volume of solution and causes iron to circulate; too low results in poor recovery.

The spigot product of the acid settlers, containing 60 per cent solids, is filtered, the cake repulped with hot water, and refiltered. Hot wash water is used on each set of Oliver filters. If this double filtering operation is properly carried out, less than 20 per cent of the zinc contained in the residues will be soluble in sulphuric acid. If 90 per cent of the zinc in the calcine was soluble this corresponds to a recovery of 87½ per cent. Fig. 5 is a diagram used in determining the zinc-plant recovery.

Filtrate from the acid filters is combined with the acid settler overflow and goes to copper precipitation tanks, where scrap zinc from the tank room and scrap iron are added to remove most of the copper from the solution.

Summing up, the results of the acid leach are: (1) solution of the remainder of the acid-soluble zinc and copper; (2) final separation of the solids from the zinc-copper solution; (3) roughing out of the copper and chlorine; (4) solution of sufficient iron to guarantee the removal of the arsenic and antimony in the neutral leach; (5) elimination of the arsenic and antimony partly redissolved in dilute acid.

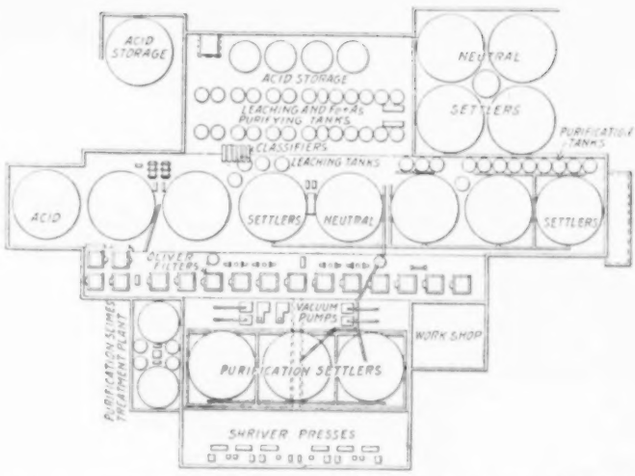


FIG. 4. GENERAL PLAN OF 150-TON LEACHING BUILDING

PURIFICATION

The overflow from the neutral settlers is pumped to twelve 10 x 20-ft. air-agitated Pachuca tanks, where it is treated, first, with recovered zinc sludge from the purification classifiers to rough out the copper; second, with zinc dust, added carefully until copper cannot be detected by the hydrogen sulphide test; third, with a definite excess of zinc dust to insure that all the cadmium is precipitated. After the addition of the zinc dust, the tank is agitated for fifteen minutes and then discharged through a drag-line classifier to one of two 10 x 50-ft. Dorr settlers in series with six 25 x 60-ft. concrete settling ponds. The pond overflow supplies eight Shriver clarifying presses; the solution after it passes the presses is as clear as crystal, and is ready to feed the tank room.

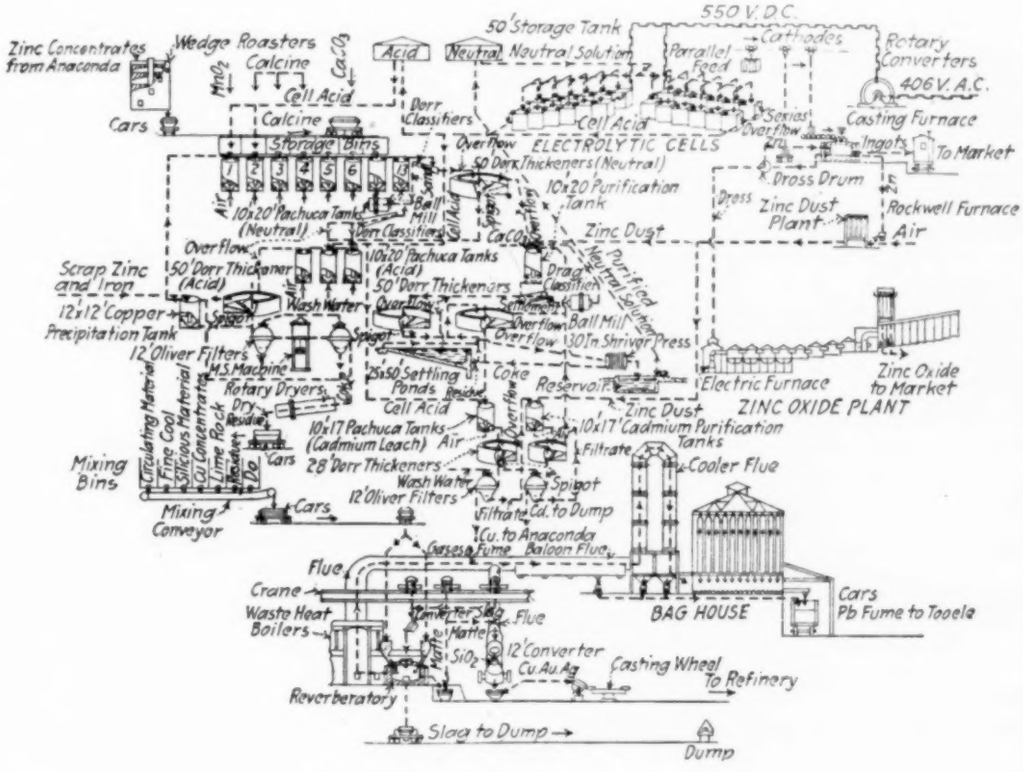


FIG. 3. FLOW SHEET OF 150-TON PLANT

Failure of the early experimenters to recognize the harmful effects of minute quantities of certain impurities is the principal reason for their disappointment. It is not safe to say that a definite amount of any impurity can be tolerated, because their harmful effects appear to be cumulative. For instance, when a small amount of copper is present (10 mg. per liter), the harmful effects of a little arsenic or antimony are greatly multiplied. Therefore safety lies in the elimination of all to the greatest possible degree. Since purification is based upon the fact that a large excess of zinc dust will completely precipitate the last traces of cadmium and

copper, to get a reasonable degree of efficiency from the zinc a recovery system supplemented by a purification-slime treatment plant is necessary.

Coarse zinc dust from the drag-line classifier is brightened in a pebble mill and reused in purification.

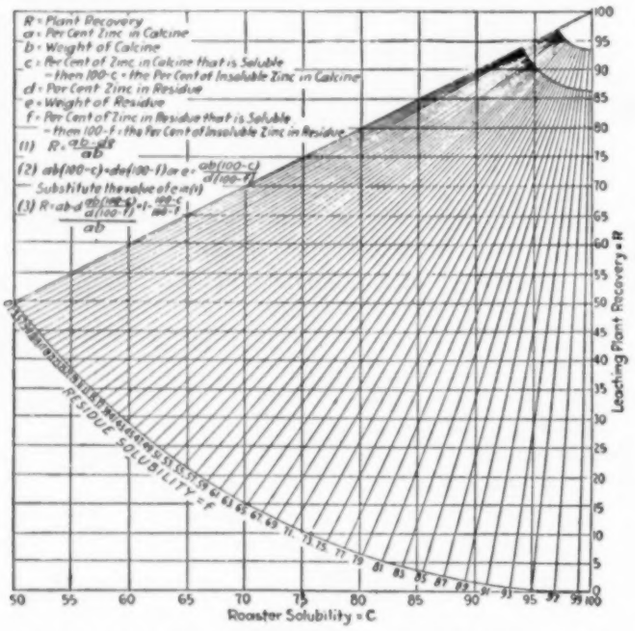

R = Plant Recovery
a = Per Cent Zinc in Calcine
b = Weight of Calcine
c = Per Cent of Zinc in Calcine that is Soluble
— then 100-c = the Per Cent of Insoluble Zinc in Calcine
d = Per Cent Zinc in Residue
e = Weight of Residue
f = Per Cent of Zinc in Residue that is Soluble
— then 100-f = the Per Cent of Insoluble Zinc in Residue
(1) R = (ab-de)/ab
(2) ab(100-c)=de(100-f) or e = ab(100-c)/d(100-f)
Substitute the value of e in (1)
(3) R = ab-d·ab(100-c)/d(100-f) · 100-f/100-c / ab
RESIDUE SOLUBILITY = f
Roaster Solubility = C
Leaching Plant Recovery = R

FIG. 5. GRAPHIC REPRESENTATION OF ZINC PLANT RECOVERY FORMULA

Based on the fact that insoluble zinc in calcine equals insoluble zinc in residue.

The sludge from thickeners and ponds is pumped to a scavenger settler, which receives all the spill and washings from the presses and the purification settling system and acts as a combination settler and slime storage tank. The overflow of this settler is pumped back to the purification tanks.

Operation of the Slime Purification Plant

The spigot product of the last-mentioned settler is pumped to two 10 x 17-ft. Pachucas until they are about one-third full, then cell-acid is run in slowly to dissolve cadmium and zinc and the solution is agitated until the copper just begins to go into solution as noted by the sodium sulphide test. The contents are then pumped to the copper settler, producing a rich slime (30 per cent copper) which is filtered on a 12-ft. Oliver filter and sent to Anaconda for smelting. The settler overflow contains cadmium and zinc; it is run to two Pachucas to which zinc dust is added in sufficient quantity to reduce the cadmium content to that of the neutral Dorr overflow.

These tanks are then discharged into a settler, the overflow being returned to the purification cycle. The spigot product contains 12 per cent cadmium and is stored for subsequent treatment.

Electrolyzing Division

The tank house contains 864 cells 10 ft. 3 in. long x 2 ft. 10 in. x 5 ft. deep divided into six groups. Cells are made of wood, lined with lead, and each contains twenty-eight anodes and twenty-seven cathodes. Cathodes are approximately 2 ft. x 3 ft. 6 in. x $\frac{1}{16}$ in. thick, made of rolled sheet aluminum and have a copper contact bar riveted to the top so that 3 ft. of the cathode is submerged. Cathodes are spaced 4 in. centers. Anodes are made of chemical lead and so cast that the copper contact bar is completely inclosed by the lead except at one end where contact is made with the conductor bar. Anodes have slightly less area than the cathodes and are $\frac{3}{8}$ in. thick. Distance from cathode to anode is therefore approximately $1\frac{3}{4}$ in. A triangular conductor bar is used and permits all of the contacts to be on the aisle side of the tank.

Each tank-room unit, or block of 144 cells, is subdivided into twenty-four cascades. Each double cascade forms a stripper unit, which is divided by a runway. Cells of each cascade are placed end to end so that the discharge of the top cells flows into the next lower cells, while the discharge of the sixth cell spills into the tail launder, which carries the spent electrolyte to storage. Solution is fed into the first five cells of a cascade; the sixth is used as a control from which hourly samples are taken and run for acid.

Current for each unit of 144 cells is supplied by a rotary converter of 5,800-kw. output at 580 volts and 10,000 amp. maximum capacity. At full load the current density is approximately 30 amp. per sq.ft. Voltage can be varied 40 volts up or down by means of a booster set. Each additional 1,000 amp. on a circuit calls for approximately 15 volts on the circuit. Figs. 6, 7 and 8 are taken from several valuable diagrams given in the paper which show current characteristics as affected by cell conditions, while Fig. 9 gives the power distribution to the whole plant.

On day shift twelve men strip the metal for each unit of 144 tanks. Nine cathodes are removed at a time and placed in a rack, which permits the stripping of adjacent sides of two plates each time one cathode is swung to the side. The bare aluminum cathodes are washed with hot water and surfaced with a wire brush

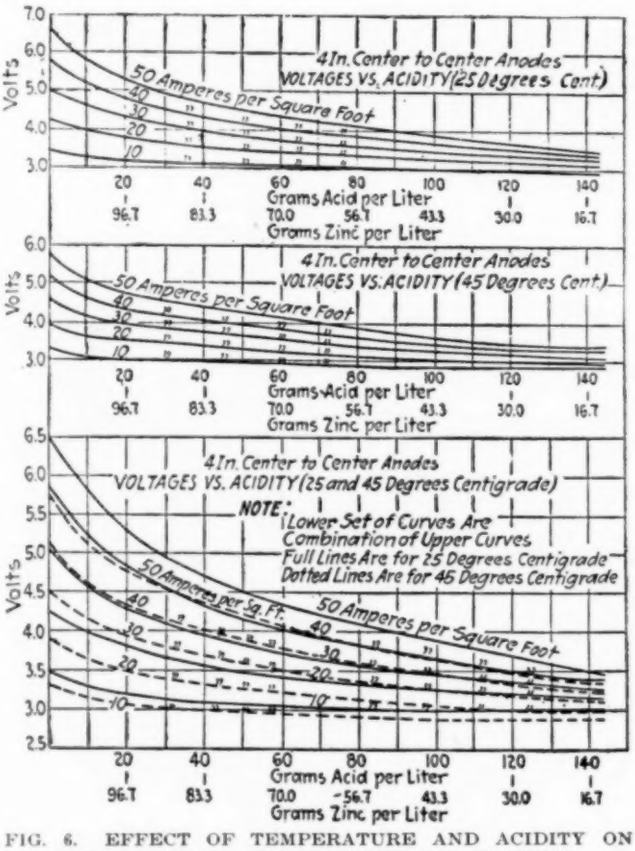

4 In. Center to Center Anodes
VOLTAGES VS. ACIDITY (25 Degrees Cent)
50 Amperes per Square Foot
40
30
20
10
Volts
Grams Acid per Liter
Grams Zinc per Liter
4 In. Center to Center Anodes
VOLTAGES VS. ACIDITY (45 Degrees Cent)
4 In. Center to Center Anodes
VOLTAGES VS. ACIDITY (25 and 45 Degrees Centigrade)
NOTE:
Lower Set of Curves Are Combination of Upper Curves
Full Lines Are for 25 Degrees Centigrade
Dotted Lines Are for 45 Degrees Centigrade
50 Amperes per Sq. Ft.
50 Amperes per Square Foot

FIG. 6. EFFECT OF TEMPERATURE AND ACIDITY ON RESISTANCE OF ELECTROLYTE FOR VARYING CURRENT DENSITIES

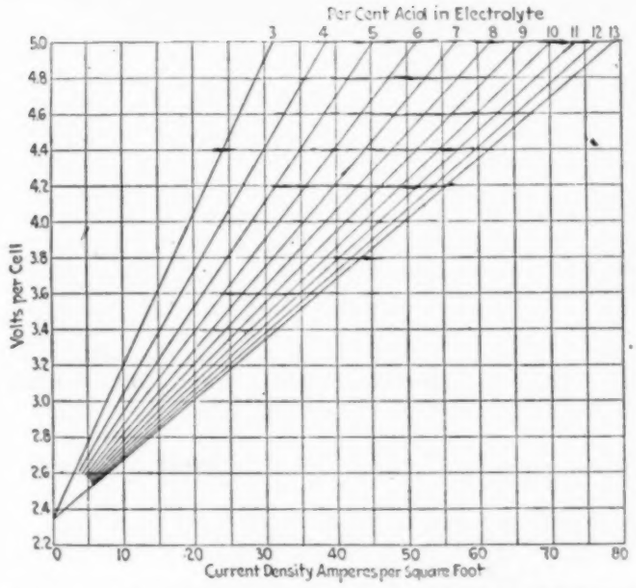

Per Cent Acid in Electrolyte
3 4 5 6 7 8 9 10 11 12 13
Volts per Cell
5.0 4.8 4.6 4.4 4.2 4.0 3.8 3.6 3.4 3.2 3.0 2.8 2.6 2.4 2.2
0 10 20 30 40 50 60 70 80
Current Density Amperes per Square Foot

FIG. 7. VOLTS PER CELL FOR DIFFERENT CURRENT DENSITIES AND ACIDITIES FOR 2-IN. SPACING OF ELECTRODES AT 34 DEG. C.

when needed. Anodes are cleaned once each month or six weeks. Zinc sheets are not washed before they are sent to the melting furnace.

Every workman in the tank room is furnished daily with a nose and mouth mask of eight thicknesses of antiseptic gauze, to filter out the mist of electrolyte always in the air and caused by gas bubbles leaving the solution and atomizing a small amount of it.

All floors are made of wood, and are insulated from the tanks, bar lines and ground. Steel columns, to the height of a man's head, are boxed with wood. Chain blocks have a strain insulator between them and the crawl. As an added precaution against electric shock, shoes with non-conducting rubber or wood soles are furnished all men employed in the tank room.

Between 1 and 1.5 oz. (28 to 42 g.) of glue per ton of metal produced, depending upon the amount of impurities in the electrolyte, is added at two-hour intervals. The judicious use of glue gives a dense deposit resulting in better melting recoveries.

Manganese dioxide is deposited at the anode and falls to the bottom of the cell, which is designed with a storage space on the bottom to hold the accumulation for six months, which is the life of the wooden insulators. Originally dry maple blocks dipped in hot paraffine were used to support the conductor bars and dead ends of electrodes; glazed tile has been found preferable where is can be used without crushing.

Melting Division

The casting plant has two coal-fired melting furnaces with a capacity of from 100 to 125 tons per furnace per day. The firebox is large and deep and is operated as a partial gas producer giving a reducing atmosphere. At intervals the dross is rabbled free of metal with ammonium chloride; once every day it is completely skimmed and further worked while hot in a revolving concrete mixer to which oil and ammonium chloride are

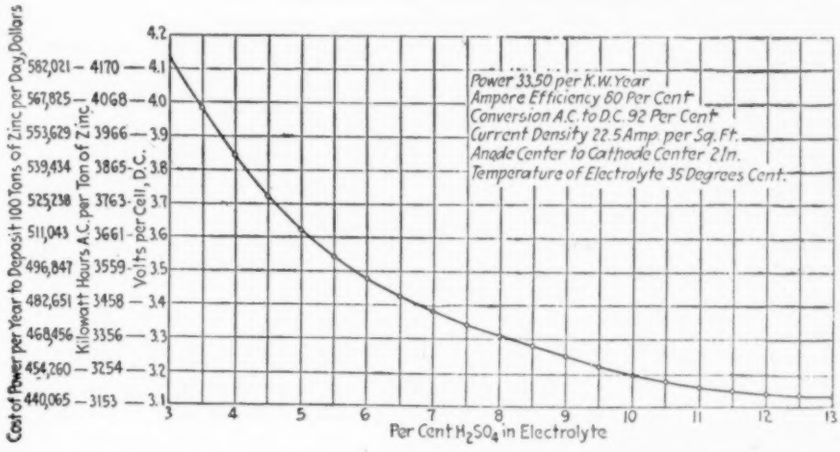

Cost of Power per Year to Deposit 100 Tons of Zinc per Day, Dollars
582,021 — 4170 — 4.1
567,825 — 4068 — 4.0
553,629 — 3966 — 3.9
539,434 — 3865 — 3.8
525,238 — 3763 — 3.7
511,043 — 3661 — 3.6
496,847 — 3559 — 3.5
482,651 — 3458 — 3.4
468,456 — 3356 — 3.3
454,260 — 3254 — 3.2
440,065 — 3153 — 3.1
Kilowatt Hours A.C. per Ton of Zinc
Volts per Cell, D.C.
Power 33.50 per K.W. Year
Ampere Efficiency 90 Per Cent
Conversion A.C. to D.C. 92 Per Cent
Current Density 22.5 Amp. per Sq. Ft.
Anode Center to Cathode Center 2 In.
Temperature of Electrolyte 35 Degrees Cent.
3 4 5 6 7 8 9 10 11 12 13
Per Cent H_2SO_4 in Electrolyte

FIG. 8. EFFECT OF VARIATION OF ACIDITY ON POWER COST AT CONSTANT CURRENT DENSITY

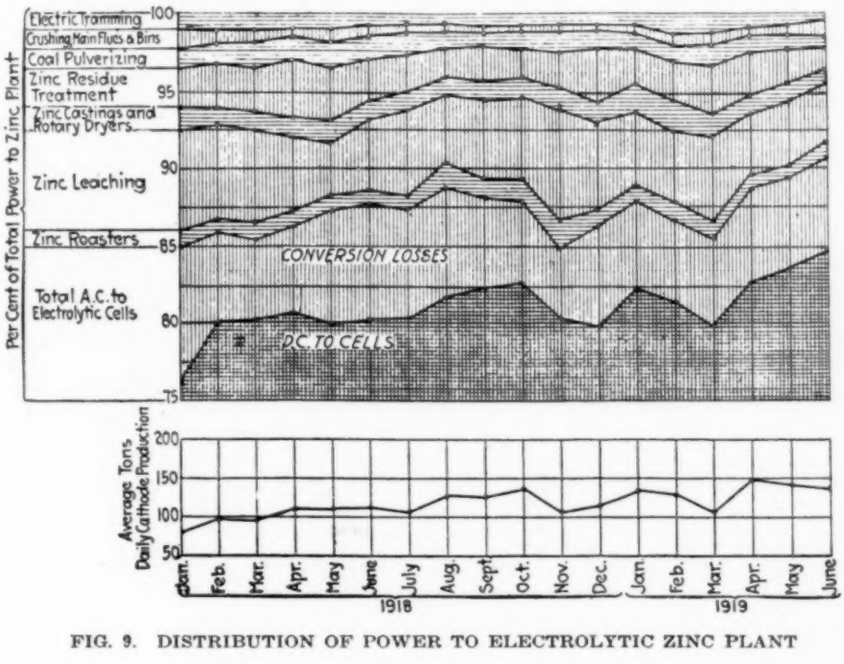

Per Cent of Total Power to Zinc Plant
Electric Tramming
Crushing Main Flues & Bins
Coal Pulverizing
Zinc Residue Treatment
Zinc Castings and Rotary Dryers
Zinc Leaching
Zinc Roasters
Total A.C. to Electrolytic Cells
100 95 90 85 80 75
CONVERSION LOSSES
D.C. TO CELLS
Average Tons Daily Cathode Production
200 150 100 50
Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec. Jan. Feb. Mar. Apr. May June
1918
1919

FIG. 9. DISTRIBUTION OF POWER TO ELECTROLYTIC ZINC PLANT

added, thus recovering approximately 50 per cent of the zinc.

Zinc Dust Plant

Approximately 8 per cent of the zinc produced in the tank room is required to precipitate copper and cadmium. The zinc atomizing plant has two units, each consisting of an oil-fired Rockwell furnace, two blowing nozzles, and a settling chamber with a superimposed bag house. Air from the nozzles strikes a small hot stream of metal at right angles, atomizing it and blowing it into the settling chamber.

Residue Treatment

The wet residue from the Oliver filters is dried in two 7 x 50-ft. Ruggles-Coles driers and three 9 x 60-ft. horizontal, single tube, rotary driers (moisture is thus reduced from 25 to 7 per cent) and then conveyed to storage

bins in 50-ton dump cars. Three 300-ton bins are used for dried residue, and one each for fine coal, siliceous ore, copper concentrate, lime rock and circulating material such as converter slag and cleanings. Each compartment discharges through a measuring chute to a belt conveyor which in turn discharges in a storage bin, supplying feed for reverberatory furnaces, and taken there by cars via local tramming system.

Furnaces are 125 ft. long x 22 ft. wide x 8 ft. high, measured from the silica bottom to the under side of the arch at about mid-length, originally built to smelt copper calcine but remodeled by lowering the bottom 2 ft., and by increasing the size of flues so as to permit as much lead fume to settle here as possible. Flue cleanings are shipped to the Tooele lead smelter for treatment. Slag is skimmed twice a shift, and stored, since it is planned to re-treat it to cover its zinc content (11 per cent Zn, 30 per cent FeO, 27 per cent SiO_2, 16 per cent CaO).

RECOVERY OF LEAD

Matte is overblown, before adding any siliceous flux, so as to expel as much of the lead as possible as volatile compounds, and the fumes are collected by flue leading to a bag house.

Fume-laden gases from the reverberatories are conducted through an 8 x 10-ft. flue to four Stirling waste-heat boilers, and thence through a 10-ft. hopper-bottomed steel flue, 1,200 ft. long, to the cooler pipes and bag house. There are thirty cooling pipes, 30 in. in diameter by 120 ft. long, arranged in parallel. Each pipe is in the shape of an inverted U and is equipped with a butterfly damper for velocity control. Whenever radiation will not cool the gases to 90 deg. C., cold air is drawn in through special doors located between the cooler pipes and the fans, which latter provide draft for the furnace and pressure for the bags. Pressure is normally about 1 in. of water. Originally the bag house contained eleven sections of 138 bags, each 18 in. x 30 ft. (45 cm. x 9 m.); in 1918 six sections were added to provide additional capacity for matte conversion. There is a cross-connection between the suction flue to the coolers and the distributor flue to the sections so that when the dampers are opened in the cross flue, a back draft results and the bags are collapsed, freeing most of the dust, and the exhaust gas from the section is forced into the bags of the other sections. However, the bags must also be shaken by hand at intervals, otherwise the fabric pores will gradually be filled. Dust is removed by screw conveyor to standard gage railway cars for shipment to lead smelters.

Thus, the object of the residue treatment is to collect the maximum amount of copper, gold and silver in a leady matte with a minimum amount of zinc, and to slag as much zinc as possible while making a fume rich enough in lead to ship as a lead product. Over a period of six months when smelting a residue of the approximate analysis 15 per cent lead, 13 per cent zinc, 2 per cent copper, 23 oz. silver and 0.07 oz. of gold per ton, 12 per cent silica, 29 per cent iron oxide, the recoveries were: copper 90.78 per cent, gold 74.05 per cent; silver 93.04 per cent; lead 72.65 per cent.

New Bamboo-Paper Pulp Plant

It is learned from Vice-Consul Thorling that a big bamboo-paper pulp plant is to be opened in the Pegu District, Burma, by F. W. Heilger & Co., managing agents for the Titaghur Paper Mills Co. (Ltd.).

Book Paper From Southern Pine*

Book paper requires for its manufacture two kinds of woods—a long-fibered wood, such as spruce, to impart strength, and some short-fibered hardwood to give the formation, finish, opacity and other printing qualities. The Southern pines are long-fibered woods, excellently suited for the manufacture of wrapping paper and fiber board, but their pitch content and the difficulty of bleaching them have heretofore been obstacles in the way of their use for white paper. These obstacles, it has been shown, can be overcome in a large measure by proper cooking conditions and improved bleaching methods. Red gum is typical of many Southern hardwoods that might be used with the pines in the manufacture of the better grades of printing paper.

The laboratory experiments indicate that one cord each of loblolly pine and red gum are capable of yielding one ton of paper, at a cost which should allow a good profit under prevailing conditions.

The utilization of the Southern pines for book paper would spread the burden of the pulpwood supply over considerable territory which is favored with a large annual growth of timber. In fact, although the bulk of the standing timber of the United States is in the far West, the bulk of the annual growth is now in the South. Pines and hardwoods are distributed throughout the Southern States in proportions well suited for the manufacture of book papers, and the forests are near the centers of paper consumption as well as the supplies of coal, chemicals and other necessary raw materials.

Margarine Industry of Hull, England

In addition to being one of the most important British centers for the treatment of oilseeds and the production of various oils, paints and colors, Hull is rapidly gaining a commanding position in the matter of the production of oleomargarine. This is practically a new industry for the district, reports Consul John H. Grout of Hull, England.

About four years ago the manufacture of compound lard was commenced, and this lard has now reached a degree of popularity that is securing for it universal use. It is generally admitted to have superseded hog lard in this district. The manufacture of margarine at Hull is a more recent development. Among the different brands produced are those intended for table use, for cake making and for pastry.

Annual production figures covering the margarine industry of the Hull consular district are at present very difficult to obtain. However, in 1915 the weekly average production of margarine in all England amounted to 2,200 tons, which was followed in 1916 by a weekly output of 2,500 tons. In 1917 the total had increased to 3,500 tons per week. In 1919 the industry made great advances, owing to the opening of new works throughout the country; the weekly production for January of that year averaged 7,500 tons, in February 6,200 tons, in March 6,400 tons, in April 6,350 tons, in May 8,500 tons, in June 6,000 tons, in July 6,000 tons, in August 4,800 tons, in September 6,350 tons, in October 5,950 tons, in November 7,500 tons and in December 5,220 tons.

From such information as is obtainable it would appear that for the year 1920 the average weekly production was in the vicinity of 7,000 tons.

*From *Technical Notes*, Forest Products Laboratory.

Pulverized Coal

ALTHOUGH experiments in the use of pulverized coal were begun nearly a century ago, the first practical application of the use of the fuel in powdered form was not made until about 1895. The cement industry, disturbed by the increasing cost of oil, sought for a low-priced fuel of high efficiency. Their plants were equipped, also, with the machinery necessary to reduce to powder cement rock or clinker and the pulverization of the less resistant fuel presented no difficulties. A series of experiments, begun in 1894, resulted in the following year in the installation of a practicable device for burning powdered coal. Its use has never been discontinued and at the present time 90 per cent of the portland cement made in the United States is burned by means of powdered coal.

Experiments with the new type of fuel were undertaken in other industries from time to time during the next fifteen years, but it is only within the last decade that the consumption of powdered coal in the United States has grown to any considerable proportions. During the calendar year 1919 it is estimated that between 10,000,000 and 12,000,000 tons of coal was pulverized for industrial consumption. Of this amount 6,000,000 tons was consumed in the making of portland cement; 2,000,000 tons was used in the iron and steel industry; copper refining consumed 1,500,000 tons, while at least 250,000 tons was used in power plants. The remaining consumption of pulverized fuel was divided among a large variety of industrial uses.

Increased Use of This Form of Fuel

A better understanding of the principles involved, together with improvements in furnace design, has overcome most of the difficulties encountered in the earlier experiments, many of which were nothing more than attempts to burn pulverized coal in furnaces intended for other methods of firing. Further study of various grades of coal with a view to their suitability for use in pulverized form, as well as the design of improved machinery for reducing coal to the necessary degree of fineness, has also contributed largely to the increased use of this form of fuel. The use of pulverized coal on a large scale has been tried in Great Britain only in the cement industry, but the urgent necessity for the conservation of fuel supplies in that country is directing attention toward it as a possible means of economy. Apparatus for burning pulverized coal has been installed also in France and Japan, while Italy has recently sent a commission of engineering experts to the United States to investigate the subject.

Economic Advantages

The fundamental economic advantage in burning pulverized coal lies in the complete stage to which combustion is carried in the furnace. The contact surface between coal and air is greatly increased by splitting the coal into numerous particles of small size. A 1-in. cube has an exposed surface of only 6 sq.in., while the same volume divided into a thousand cubes of 0.1 in. has an exposed area of 60 sq.in., and if the division be carried to one million cubes 0.01 in. on a side, the exposed area in which combustion takes place is increased to 600 sq.in.

The second advantage in the pulverization of solid fuel is the fact that it floats in the air, spreads and is carried off by even small air currents. This makes the intimate mixture of coal and air very easy. It simplifies the construction of burners and guarantees economical combustion. The finer the coal is powdered the more nearly ideal conditions for complete combustion are approached.

Where proper apparatus and methods are in use, however, other more tangible economies are effected by the use of powdered fuel. The labor cost of firing is materially lowered and losses during short periods when steam pressure is not required are reduced to a minimum. No air is allowed to pass through the furnace when firing operations stop, so that the radiant heat of the furnace is absorbed by the boiler, avoiding the losses which occur with grates or stokers through the constant burning up of fuel and incomplete combustion of the gases generated from banked fires. The time necessary to get up steam is reduced by half when pulverized coal is substituted for the same fuel in lump form. Recent experiments also show an economy in fuel consumption, which in some instances is said to be as high as 30 per cent.

Low-Grade Coals Now Utilized

Until very recently the impression has prevailed that only certain grades of bituminous coal were suitable for powdering. Early experiments in the use of low-grade coal were nearly all failures, but as the conditions necessary for practical operation have become more thoroughly understood the low-grade coals have been utilized successfully. All the most recent developments in the use of powdered coal as a fuel for steam-generating plants have been made with anthracite culm, at one time definitely abandoned as a fuel suitable for powdering. High volatile soft coal gives best results, but mixtures of such a grade of coal with anthracite culm have proved entirely satisfactory and pulverization may be applied to any solid fuel, peat, lignite or bituminous coals of any grade, as well as anthracite and coke. All of these fuels are burnt successfully in powdered form, because the inherent advantages of exact regulation of air and combustible matter, with a proper mixture of both, may be secured. Higher temperatures than are possible with lump fuel can be maintained in furnaces fired by powdered coal because the quantity of excess air is only about 20 per cent compared with an excess of from 50 to 200 per cent with hand or stoker fired coal.

Method of Powdering

In the preparation of coal for use in the powdered condition the first operation is a crushing to lumps about one inch in size. Following the crushing the coal should be dried down, if possible, to less than 1 per cent of moisture. The crushed coal is then passed through a magnetic separator, which removes bits of steel or iron that would interfere with pulverization. Drying is desirable both for proper pulverization and to make the fuel burn freely. The coal is dried by being passed through a revolving shell, the temperature of which is maintained at a point high enough to cause the vaporization of practically all the moisture contained in the crushed fuel.

After being dried, the coal is pulverized to its final degree of fineness, such that 85 to 90 per cent will pass through an aperature $\frac{1}{100}$ in. square. The powdered fuel is conveyed directly from the pulverizing plant to the furnaces, either by a system of screw conveyors or by air pressure. It is fed to the burners through a nozzle under light air pressure.

An Engineer Who Anticipated Hoover

By P. B. McDonald
Assistant Professor of English, College of Engineering, New York University

WHILE Herbert Hoover stands pre-eminent today as the type of American who won high success abroad by applying science and economics to foreign problems in a characteristically American way, he should not be thought the first of that type. To a certain extent Benjamin Franklin anticipated him by over a century, and astonished Europe by his shrewd ability and use of scientific methods. But there was another American, contemporary in part with Franklin, who won striking success in Europe but whose remarkable accomplishments are little known. This was Benjamin Thompson of Woburn, Mass., later Sir Benjamin Thompson and Count Rumford of the Holy Roman Empire, to whom England owes its Royal Institution and to whom Bavaria erected a splendid bronze statue, later duplicated at Woburn.

Benjamin Thompson was a scientist and administrator. He proved that heat is a mode of motion, not a fluid substance as it was then thought, and he determined within 10 per cent the dynamic equivalent of heat, later corrected by Joule. Since Thompson, or Rumford as he perhaps should be called, anticipated Joule by forty-two years, Dr. E. E. Slosson is justified in suggesting that the unit called the joule might better have been called the rumford. (See Slosson's essay on Rumford in "Leading American Men of Science," edited by David Starr Jordan.) But, like most practical Americans, Rumford believed in applying his knowledge of science. He improved the design of fireplaces, founded the science of interior ballistics by experiments with cannon and gunpowder, anticipated the "fireless cooker" of today, helped solve the question of the best covering for steam-pipes by observations on radiation, gave the world much-needed suggestions about clothing, contributed to the development of knowledge about lamps, colors, meteorology, the three ways in which heat travels, etc.

Founded the Royal Institution

As an organizer and administrator, he reformed the Bavarian army, housed the beggars of Munich and put them at useful work, and got a number of the leading men of England to contribute to the Royal Institution which he founded. This institution has done more for the advancement of science than probably any university in the world. Among its famous workers have been Davy, Faraday and Tyndall, and today it remains an active influence for research, housed in a palatial building in London. Other evidences of the foresight of this Yankee Count survive in the Rumford professorship which he founded at Harvard, and in the Rumford medal of the Royal Society of London and the Rumford medal of the American Academy of Arts and Sciences. When Rumford died near Paris in 1814, the great Baron Cuvier eulogized him before the French Institute.

But this distinguished scientist and administrator did not have things all his own way, as a record of his accomplishments might indicate. Though his family had lived in America for over a century, he left this country at the outbreak of the Revolution and fought against the colonies as a British officer. This was after he had offered his services as a brilliant young man to Washington and been refused because his enemies were jealous of his rapidly increasing eminence. In England he found instant recognition and was made cavalry Colonel and Under Secretary of State while yet in his twenties. After the Revolution, he made the acquaintance of the Elector Palatine of Bavaria by his fine appearance on horseback, and was offered exceptional honors to stay in Munich and devote his talents to the government there. In Bavaria he became Count, Privy Councilor, Minister of War, Chief of Police, and Chamberlain to the Elector Palatine.

A Personality That Thrives in a Monarchy

In person, Rumford had excellent manners and a ready flow of language, but he was opinionated, obstinate and disposed to have his own way, especially about little things, such as concerned his theories of clothing, cooking and household management. His unusual personality was the kind that prospers more in a monarchy than in America, because aristocracies make more allowance for eccentric geniuses than do democracies. If he had remained all his life in the land of his birth, he likely would never have risen higher than some petty job at the beck of a captain of industry. In England the Colonial Secretary of State, after one interview, recognized the ability of the young New Englander and gave him a place in the Colonial Office, making him a member of his own household. Later in Bavaria the Prince Maximilian spoke to him and invited him to dine because he liked his handsome appearance at a military parade where Rumford was a spectator. Directly afterward he was introduced at the court in Munich and was offered inducements to stay there in official capacity.

It is evident that, besides resembling Hoover in attainments in applied science and organization, he was like him also in rising from a poor American boy to an associate of kings and a great philanthropist. Hoover, however, has found honor in his own country while yet a comparatively young man, whereas Rumford has never been well known by Americans, and was even reviled as a traitor for many years until a more tolerant attitude grew up toward the Loyalists. Possibly Hoover would have become a great engineer if he had remained in America, instead of seeking his fortune in Asia and Europe; as to that, however, it is impossible to decide, for if he had never left this country his life would have been widely different. America offers prosperity to men of a certain pushful and businesslike bent, but does not confer favors on so wide a range of talents as do the older civilizations where life is more diversified and success is less standardized. Probably, just as there are Europeans who succeed better in America than in Europe, so there are particular types of Americans better adapted to succeed in Europe than in America. Such an interchange is beneficial to both continents, since it makes for distribution of ideas, and adds to the variety of minds available to help solve the problems of any one country.

Correction

In the article on "Comparison of Various Methods of Water Purification," by William Macklin Taylor, published in the Jan. 19, 1921, issue of CHEMICAL & METALLURGICAL ENGINEERING there was a typographical error. In the table on page 124 the hardness of water treated through a zeolite water softener, calculated to calcium carbonate, was given as 6.50 grains per gallon. This should have been 0.50 grain per gallon.

Costs—A Short Study of Factory Economics*

A Manager's Point of View of the Functions of and Services to Be Received From Factory Cost Departments — Factors of Interdependence of Costs — Maximum Net Returns on Groups — Distribution of Ledger Totals—Forms for Recording Operations—Statistics, Reports and Item Analyses

By A. G. PETERKIN

THE layman's idea of a cost system is a mechanical routine which month by month turns over to the sales department the cost of each of the materials which it sells. As a matter of fact, it has been attempted in many cases to put this idea into operation. I think it is true that the result has been a compilation of figures which fall under the head of "statistics" in Walter Bagehot's famous expression: "There are lies, damn lies and statistics." The problem which confronts the manager of a factory is not the mechanical grinding out of so-called cost figures, but a study in economics.

What Should a Cost System Do?

In the first place, a cost system should give information to the sales department which will enable its members if possible to sell the production at a profit. The sales department, however, is not able to control the market price of certain commodities, which are set by outside conditions and the selling price of other commodities. For example, if a substitute material is offered, the limitation is imposed that the selling price must have some definite relation to the price of the material substituted. In such cases, given a process of manufacture, the cost system is required to tell the price at which the raw materials must be bought to enable the material to be marketed.

It is of no less importance that the system should tell the factory management and the sales department under just what conditions the costs submitted are possible, and in what way they will be affected by changes in method of manufacture, and by increase in the individual or total volume of production.

The cost system might be required to produce a sense of financial responsibility in the heads of all the various departments, from the top down. This is particularly true of corporations or large businesses where the combination expected to give results is that of "your brains and someone else's money." The repair department, for instance, should be run as far as it is possible in the same way as a separate business which was furnishing the same service to the plant. The head of every production department will, to my mind, work to better efficiency when it is required of him that he think in terms of dollars and cents as well as in terms of men, pounds and gallons; he should run his department in the same spirit as he would were he using his own money. So far as possible, every man should be required to know how much money he is spending for every item where the discretion he uses in his daily work will influence that item.

When once reliable cost figures have been established and analyzed, it is more important to obtain information looking toward the control of the expenditures making up the cost than to repeat the calculation of the final figures at frequent intervals to the exclusion of such information. The one method leads to irritating post mortems; the other avoids them. As in sport, so in business, watch your stroke, and let the score take care of itself.

Interdependence of Costs

In setting out to arrive at such results at least one simple principle must be kept in mind. When once a factory has been organized to turn out any given set of products, so far as cost is concerned every one of those products becomes to some extent interdependent. To get a definite cost figure on any one of them, the cost of each one of the others must be fixed at the same time. The more varied and complex the operations of the plant are the truer this is. It is least true in a factory, if such a one exists, where each one of the products is independent of the others so far as labor, raw materials and intermediate materials are concerned. In such a case as that, the interdependence lies mainly in the overhead, and the variation in cost will arise from the difference from time to time in what may be called the degree of saturation of the overhead. When the volume of production which a given organization can turn out is the maximum, the costs will be lowest, and as the volume decreases the cost of each one of the different materials will go up.

This factor of interdependence, however, in the chemical business is influenced much more by another condition than by overhead expense: If the decision is made to manufacture a certain material by a chemical process, one is almost always confronted by the necessity of producing another or even several others simultaneously. These "byproducts" may or may not be useful and valuable. The growth of the industry has largely been effected by making them so. The two or more products from such a process may have been subjected to exactly the same procedure and no more expense incurred in making one marketable than any of the others; on the other hand one or more of the products may have necessitated a disproportionate expense. Does this extra expense as an item of cost belong to the products directly responsible; or should the total expense be divided equally among the group? Assume for a moment that the expense is allotted as directly as possible among such a group of complementary materials and costs figured on this basis are given to the sales department. What naturally happens? Vigorous selling of the profitable members and an accumulation of the less profitable! Finally of course all have to be disposed of and the net result is a profit or loss on the group. The only rational basis for computing costs, and profit, is on the group considered as a unit. No arbitrary fixing of values within such a group changes the basic fact that the profit is made on the sale of the

*Read before the American Institute of Chemical Engineers, New Orleans, Dec. 6, 1920.

entire production, although the use of such values may in some cases be a convenient and good method of studying the group profit. Such arbitrary values placed on certain members may not materially affect the cost of the other members, either in amount, in variation or in both. For example, in the manufacture of nitro products, with the attendant production of "spent acid," to figure a cost and profit on the group would merely tend toward confusion. The market value of the "spent acid" can be ascertained with considerable ease; the

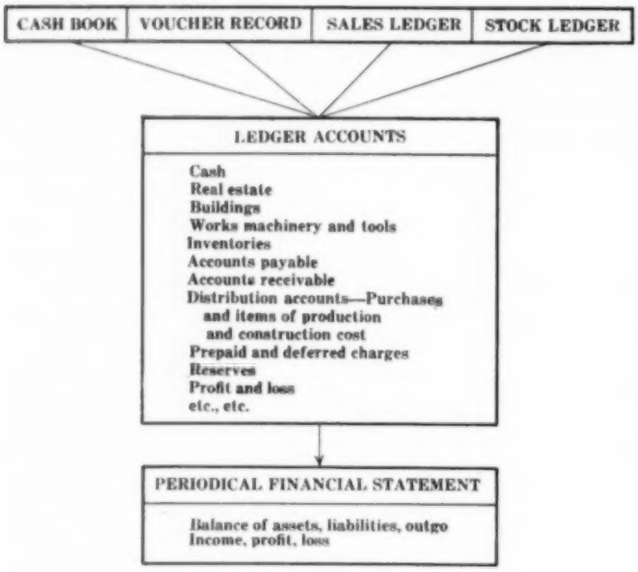


FIG. 1

placing upon it of such a value will throw all the cost and all the profit to the nitro product, and will clearly give the information necessary to a proper manufacturing and sales policy.

Maximum Net Returns on Group of Products

Possibly the best example of this phase of the subject is the case of a factory refining oils. Each crude worked may give some amounts of the same materials and at the same time products peculiar to itself. Each crude, also, can probably be worked up in various ways to produce several sets of products. The attempt to follow each intermediate step in the refining process, to find the cost of the intermediate products and so on to the finished products, results in figures which are valueless in most cases. The question here is of the proper profit on the group of products from one crude, and the most profitable group to make from that crude. Frequently every finished product has an established market price, and the price which can be paid for the crude has to be determined by taking the difference between the combined market value of the entire production, and the total working cost, freight, profit, etc.

There are many cases where evaluation of individuals is necessary in which the products cannot be evaluated by placing arbitrary values on the minor members, and dividing the remainder of the cost proportionately. A rule capable of fairly general application is to divide this remainder among the major products in the proportion of their market values. The one point which should never be lost sight of, however, is that the manufacturing and selling policy should be governed by the net return on the group.

Another phase of the same problem is the question of the price at which a finished product from one process shall be charged as a crude to another. If such a material be marketable in the maximum volume possible to produce, it might well go into the subsequent process at its market price, since the only justification for the expense of further fabrication is a profit greater than can be obtained by its sale. The first process must then be given the credit for the profit which would have accrued had the sale taken place. If the object of further processing is to take care of an otherwise unmarketable excess, the same reasoning would lead to its being charged in as a crude at not more than actual cost.

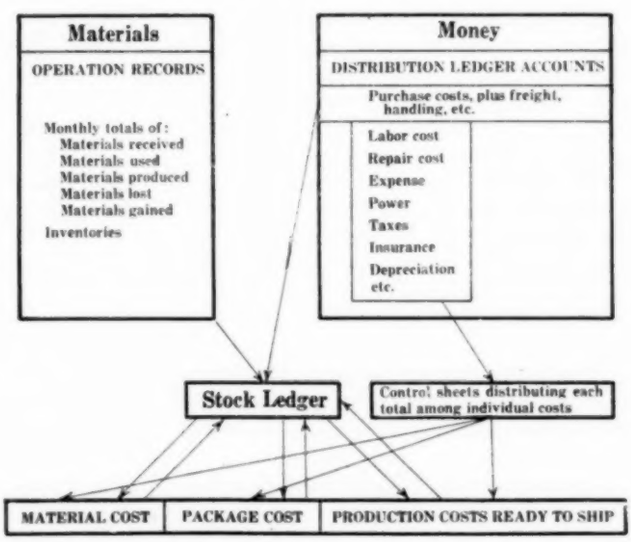
Before going into the details of the actual work of a cost department, the relation between the bookkeeping and the cost systems should be clear. Fig. 1 shows the layout of the former; Fig. 2, that of the latter.

Distribution of Ledger Totals

The cost system is not an essential part of the bookkeeping system; it is an analysis of the bulk cost of the operations carried out; it does not even furnish, necessarily, the value of each item of the inventory. Of course, in possibly the majority of cases, the individual inventory items are placed on the books at a value figured out by means of a more or less mechanical system, but exceptions always have to be made where such a value bears no relation to the actual market value of the material. It is an unfortunate fact that occasionally materials are manufactured at a cost which is greater than the market value, and the inventory based on such a cost would certainly be inflated by at least the difference between the two values.

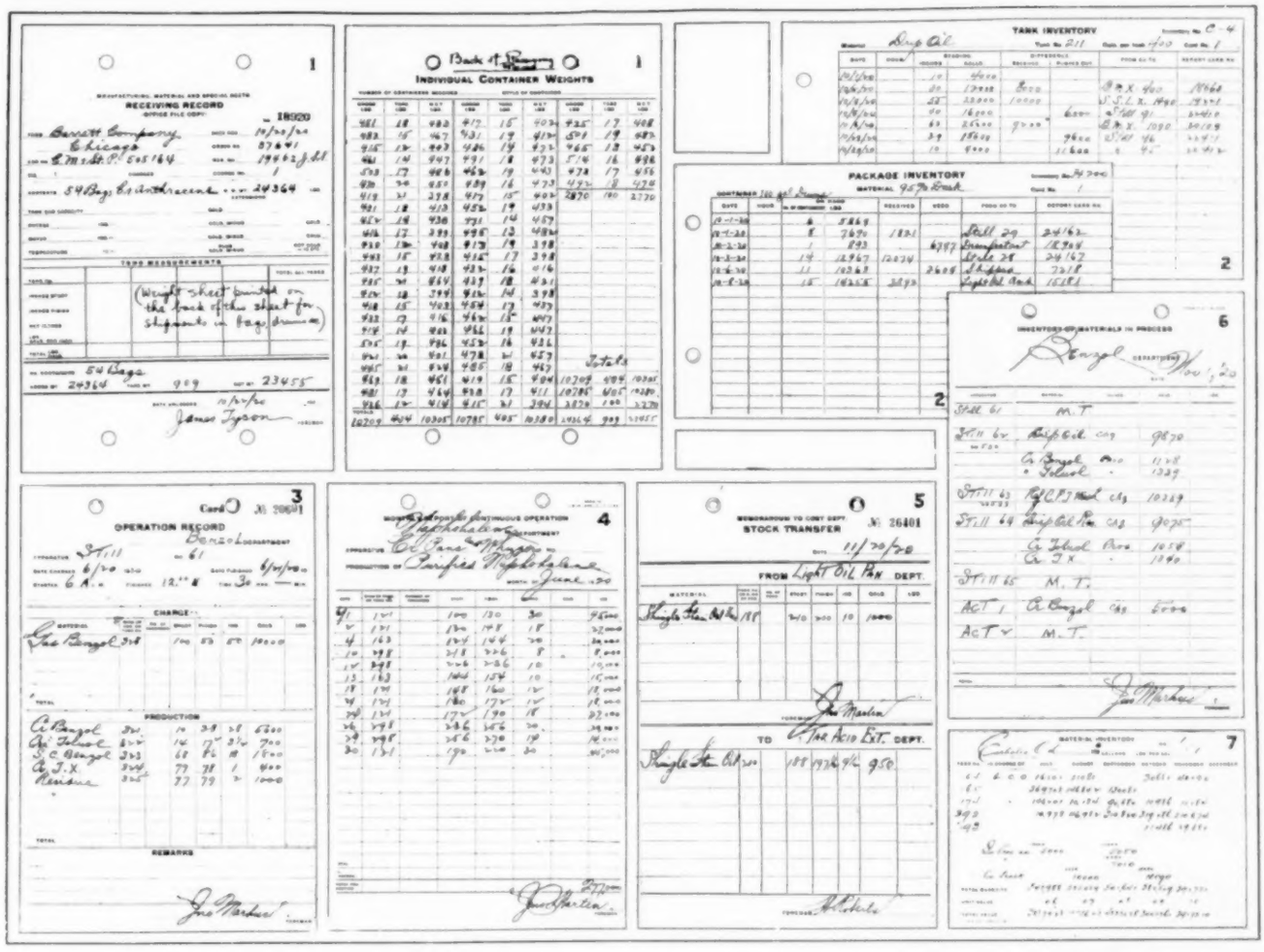
To go now to the methods to be employed in compiling plant statistics, and to the finished form they shall take:

The direct charges to any product or group of products, for superintendence, labor, repair, materials, etc.,



COST OF GOODS SOLD
SELLING AND ADMINISTRATION COSTS
TOTAL COST
SALES VALUE
NET PROFIT

FIG. 2



are calculated by distributing the ledger totals for these items by means of the usual code system, using report blanks for record of labor-hours, etc., placed in the hands of the foremen or workmen as may be judged best.

The question of the method to be used in assigning indirect charges, superintendence and various expenses covering several departments, the plant burden, etc., is a vexed one. So far as possible, each one of the items going into any such general expense account should be spread over the products necessitating it on a logical basis applying to the individual item alone. The cost of the control laboratory, for example, can as a rule be split up and charged to the products involved, on the basis of the actual cost of the tests made for each one. Such few items as cannot be treated in this way—for example, office expense or general management—have necessarily to be grouped together and prorated on an arbitrary basis. The basis most generally used is that of "productive" labor; the products are charged with their quota of expense calculated from their proportion of the direct labor in the plant. Such a general method, of course, cannot give even an approximation of the truth, unless the labor entailed in each of the group of processes employed in the plant depends on the volume of production rather than the kind. It is obviously true that some processes requiring but little labor consume an altogether disproportionate amount of the expense of superintendence, development, etc. The "punishment must be made to fit the crime," and no rule for such prorating of overhead capable of general application can be laid down.

In general, I believe it is true that yield is the most important item of cost in the chemical industry. The first essential, therefore, in any "chemical" cost system is the obtaining from the factory of accurate figures representing the operations carried out. For that reason I shall go in detail into one method which attempts to do this in a manner which leaves no figures to the imagination.

In order to follow the path of raw materials through a process all the way from the purchase of the crudes to the output of the refined materials, it is necessary to check the weight, or volume, or both, as it is received into the plant; to check the losses or discrepancies caused by errors of measurement as it passes from one part of the plant to another and into the actual apparatus where the process is carried out; to record the amounts of materials produced, both in intermediate stages and in the containers on the railroad ready for shipment to the customers; and to record the amounts of materials in process and in stock at the inventory period. It is important that the means employed to do this should enable one to detect physical losses at the time they occur.

Form 1 of the accompanying diagram is a receiving report which is so arranged that the amount of material arriving in any kind of package can be recorded as compared with the actual amount received into the storage.

Form 2 is a continuous inventory card, by means of which the individual foreman keeps a record of each lot of each material placed under his supervision. On it he records every movement in or out of the tank, bin,

PLANT BALANCE SHEET—JUNE 1, 1920

	May 1	June 1	Increase	Decrease
May 1: Asset value as per financial statement	2,000,000 00			
June expenditures as per voucher record and journal entries	500,000 00			
Assets:				
Cash	$25,000 00	$26,000 00	$1,000 00	
Accounts receivable	15,000 00	18,000 00	3,000 00	
Merchandise inventories	500,000 00	460,000 00	.....	$40,000 00
Stores and supplies inventory	100,000 00	110,000 00	10,000 00	.....
Fuel	20,000 00	25,000 00	5,000 00	.....
Real estate	200,000 00	250,000 00	50,000 00	.....
Buildings	400,000 00	500,000 00	100,000 00	.....
Machinery and tools	600,000 00	650,000 00	50,000 00	.....
New construction	100,000 00	25,000 00	.....	75,000 00
Furniture and fixtures	25,000 00	31,000 00	6,000 00	.....
Prepaid charges	15,000 00	12,000 00	.....	3,000 00
	$2,000,000 00	$2,107,000 00	$225,000 00	$118,000 00
			118,000 00	
			107,000 00	
Production cost for May	.....	.....	393,000 00	
Total, expenditures	.....	.....	500,000 00	

lot of drums or barrels, or whatever the storage may consist of, and in addition must show the source of incoming material, the point to which outgoing material has been sent, and give the identifying number of the card on which the amount moved has been recorded. Each foreman is provided with a calibration card for each one of the group of tanks for which he is responsible, from which he can read directly the gallons corresponding to each of his measurements.

Forms 3 and 4 show two kinds of operation records upon which can be entered figures representing almost any kind of operation. For a discontinuous operation, the charge and corresponding production are recorded on the upper and lower halves of the same card. For a continuous operation two forms are used, one for recording the successive charges, and the other the successive productions. The latter has a space on which

WEEKLY REPORT OF CONSTRUCTION

Appropriation No. 3169 Amount $22,000.00
Work Improvements and Additions Plant
Code No. 36-1657

1920	Cash Expenditures	Liability	Total for Week	Total to Date	Balance Unexpended
May 24	$1,842.87	$165.00	$2,007.87	$2,007.87	$19,992.13
May 31	1,084.11	12,210.37	13,129.48	15,137.35	6,862.65
June 7	337.61	779.64	1,117.25	16,254.60	5,745.40
June 14	69.96	347.83	417.79	16,672.39	5,327.61
June 21	158.53	914.78	1,073.31	17,745.70	4,254.30

PRODUCTION COST

Opening inv. naked materials			$748,108.74
Purchases			314,932.64
Cost of plant operation:			
Process labor		$38,602.49	
Salaries		1,500.00	
Fuel and power:			
Labor	$4,309.07		
Materials	28,837.67		
		33,146.74	
Team, cart, and loading:			
Labor	332.41		
Materials	332.41		
		664.82	
Repairs:			
Labor	$18,000.00		
Materials	12,000.00		
		30,000.00	
Expense:			
Labor	$15,675.00		
Materials	11,825.00		
		27,500.00	
Rents		200.00	
Taxes		966.30	
Insurance		4,534.15	
Depreciation		9,531.92	
			146,646.42
			$1,209,687.80

Opening inventory:			
Packed material and empty packages			$156,848.91
Packages and ship. material purchased			22,660.66
Cost of packing and shipping:			
Shipping labor		$3,791.02	
Team, cart, and loading:			
Labor	$990.00		
Materials	1,044.49		
		1,994.49	
Expense:			
Labor	$1,364.03		
Materials	909.35	2,273.38	
			8,058.89
Cost of materials packed			349,308.92
			$536,877.38

Closing inv. naked materials	$860,378.88
Cost of materials packed	349,308.92
	$1,209,687.80

Closing inventory:	
Packed material and empty packages	$143,877.38
Cost of materials shipped	393,000.00
	$536,877.38

ANALYSIS OF PROFIT

Month June, 1920

Process or Crude	Factory Cost	Sales and Administration Cost	Total Cost	Total Return	Profit	Loss	Six Months January to June Profit	Six Months January to June Loss
1	$25,000.00	$2,500.00	$27,500.00	$32,500.00	$5,000.00	.....	$35,000.00	.....
2	10,000.00	1,000.00	11,000.00	13,000.00	3,000.00	.....	15,000.00	.....
3	75,000.00	7,500.00	82,500.000	80,000.00	.....	$2,500.00	2,500.00	.....
4	122,000.00	12,200.00	134,200.00	150,000.00	16,000.00	.....	100,000.00	.....
5	2,000.00	200.00	2,200.00	2,500.00	3,000.00	.....	.....	$10,000.00
6	180,000.00	18,000.00	198,000.00	190,000.00	.....	9,000.00	.....	42,000.00
7	200,000.00	20,000.00	220,000.00	250,000.00	30,000.00	.....	150,000.00	.....
Totals	$614,000.00	$61,400.00	$675,400.00	$718,000.00	$57,000.00	$11,500.00	$302,500.00	$52,000.00
Net profit	.....	.....	.....	.....	45,500.00	.....	$250,000.00	.....

COST SHEET

Month Process or Crude

CHARGE

Expenses	Raw Materials					Intermediate Materials					Finished Products					Total Cost
	Name	Gal.	Lb.	Unit Value	Value	Name	Gal.	Lb.	Unit Value	Value	Name	Gal.	Lb.	Unit Value	Value	
Labor																
Salaries																
Fuel and power																
T. C. and L.																
Repairs																
Expense																
Rents																
Taxes																
Insurance																
Depreciation																
Totals																

Intermediate materials usually form an element of uncertainty, particularly when the cost period is short. Their use and production tend to obscure yield; their value or cost is usually a matter of judgment.

PRODUCTION

											Sales Values	
Totals												

The division of the cost among the finished products is usually a matter of judgment.

EXPENSE

Month June, 1920

Analysis		Summary		
Purchasing dep't		$1,200.00		
Traffic dep't		1,300.00		
Accounting dep't:				
Production cost	$1,000.00			
Construction cost	650.00			
Finance and accounting	600.00			
Paymaster and timekeeping	1,000.00	3,250		
General office:				
Repair and construction	$500.00			
Stenographic	1,000.00			
Mail and messengers	500.00	2,000		
Management		500.00		
Stationery, postage, telegrams		800.00		
Traveling expenses		150.00		
Janitors and washers		500.00		
Telephone		300.00	Office	$10,000.00
			Lunch club	250.00
Salaries—routine, samples, office		$5,500.00		
Salaries—research, not charged direct		3,300.00		
Stores and stationery		500.00		
Janitors and washers		500.00		
Miscellaneous		200.00	Laboratory	10,000.00
Plant nurse and hospital bills		$350.00		
Plant doctor		250.00		
Dispensary supplies		200.00		
Payments to injured		311.67		
		$1,111.67		
Received from insurance company		111.67	Medical	1,000.00
Guards		$2,000.00		
Safety, employment, advertising		1,000.00		
Taxes, water, gas		1,000.00		
Janitors, towels, stationery		1,500.00		
Pension		150.00		
Team hire		100.00	Works	5,750.00
			Miscellaneous	200.00
Total				$27,200.00

to record at monthly intervals the amount of material in the apparatus at the end of the month, so that the production corresponding to the charge for the period can be calculated.

Form 5 shows a form arranged for record of transfer of material from one part of the plant to another, where such material is not going through a process, and enabling a record of discrepancies between delivered and received amounts.

Form 6 contains a complete list of all apparatus under the charge of each process foreman, on which to record the material charged to the apparatus, the production from which is incomplete at the time of the inventory.

Form 7 is used to determine the inventory of each material in the plant at the end of the month, or at the end of whatever the cost accounting period may be. The figures on this inventory card are posted from the running inventory cards kept by the foreman.

From these reports, properly checked and recapitulated, a complete ledger statement can be made up, which, if the records have been accurately kept and carefully checked, should give an exact balance. Inasmuch as every amount of material moved has been recorded on one or the other of these forms, and the movement checked by the cost department, there is no possibility except through human fallibility (that troublesome factor in all "systems") of any quantity of material not being on the cost department records.

ANALYSIS OF REPAIRS

Department—Light oil—Oils

Charge No. 6-A-1

Job	Description	Week June 1, 1920 Labor	Week June 1, 1920 Material	Week June 8, 1920 Labor	Week June 8, 1920 Material	Week June 17, 1920 Labor	Week June 17, 1920 Material	Week June 24, 1920 Labor	Week June 24, 1920 Material
1	New bottom in still 443	$100.00	$50.00	$75.00	$30.00	$150.00	$25.00	$50.00	.....
7	Repair flow box still 441	5.00	3.00	.....	.....	.....	.....	.....	.....
9	Repair line to pump 165	1.50	.....	10.00	4.50	.....	.....	.....	.....
21	New cock on catchall tank 3	2.50	10.00	.....	.....	.....	.....	.....	.....
23	Repair brickwork on still 450	.....	.....	35.00	100.00	75.00	15.00	.....	.....
24	Repair steam leaks at tanks	.....	.....	4.00	1.00	10.00	1.50	15.00	3.50
	Material charged directly to dept. (Oils, waste, ice, clogs, etc.)	.....	48.00	.....	27.00	.....	10.00	.....	25.00
	Total labor and material per week	$109.00	$81.00	$124.00	$162.50	$235.00	$51.50	$65.00	$28.50
	Total labor and material as above					$865.00			
	Direct purchases (from distribution ledger)					150.00			
	Overhead (from distribution ledger)					155.00			
	Total					$1,170.00			

NOTE.—Repair costs should be so kept that such detailed analysis as this can be furnished readily on request, to explain, for example, unusual fluctuation in department total.

LABORATORY COST SHEET

Month June, 1920

Analysis		Summary	
Salaries	$4,200.00		
Supplies from laboratory stores	800.00		
Supplies from stationery stores	50.00		
Supplies from repair stores	25.00		
R. & C. labor and supervision	50.00		
Crude materials from stock	5.00		
Finished materials from stock	50.00		
Containers from stock	15.00		
Advertising	10.00	Routine	$5,205.00
Salaries	$4,800.00		
Supplies from laboratory stores	225.00		
Supplies from stationery stores	5.00		
Crude materials from stock	2.00		
Finished materials from stock	2.00	Research	5,034.00
Salaries	$150.00		
Supplies from laboratory stores	10.00		
Supplies from stationery stores	1.00		
Finished materials from stock	150.00		
Containers from stock	25.00	Samples	336.00
Janitors' and bottle washers' wages	$500.00		
Salaries	800.00		
Supplies from stationery stores	60.00		
Traveling expenses	35.00		
Laundry	30.00		
Gas	25.00		
Electric power	100.00		
Manufacturing insurance	85.00		
Manufacturing taxes	75.00		
Manufacturing depreciation	300.00		
Water consumed	65.00		
Repairs to building and equipment	350.00	Service, etc.	2,425.00
Total cost			$13,000.00

Let us turn now to the consideration of the statistics which should be obtained from a cost department to control properly the operations in a chemical factory.

The manner in which the figures are presented, if they are to be used, is important. First, no matter whether one is studying the whole plant or any particular part of the plant, one should go from the top down. The first figures examined should represent a summary of the expense of the operations under examination; they should omit detail and present a birdseye view. It is not difficult to remember, say, twelve items going to make up a total, nor to understand and remember the relation between twelve such figures. If it is attempted to study a total comprising 144 items, the average mind merely becomes confused, arrives at no decision, and no picture of the operations represented by the figures remains. Condense the 144 figures, however, into twelve sub-totals, the relations between these are easily grasped and they furnish a definite picture. Analyze each one of the twelve items further into twelve more, and each of the subdivisions becomes clearer and more intelligible as its detail is studied. The twelve principal subdivisions then become mental pegs on which to hang the remaining 132 of the figures in easily comprehended groups. Skillful summarization is the secret of useful statements. Diffuseness is the curse of cost accounting.

The total list of reports submitted, each covering monthly or longer intervals, might be somewhat as follows:

1. Complete balance sheet showing all the money spent during the month, and the main departments where the expense was incurred.
2. Analysis of profit.
3. Analysis of the total cost of all production under a few headings of direct expense.
4. The volume of production from, and cost of the working of individual processes or crudes. (The form of this report should be particularly noted. It does not provide for the computation of the costs of intermediate materials; these are supposed to be estimated by the technical staff. By estimating the value in finished products of the intermediates used and produced, the yield on the entire process can be calculated. The attempt to get a cost on each operation of a process is usually more expensive than the results are valuable.)
5. Analysis of the plant expense.
6. Analysis of cost of repairs.
7. A detailed statement of sales, giving volume and value for each commodity. This form is not illustrated.

REPAIRS 1920

	January	February	March	April	May	June
Dept. 1	$8,473.23	$8,732.74	$11,655.98	$6,570.78	$9,866.89	.....
Dept. 2	2,340.85	1,390.46	2,116.37	5,116.62	5,308.05	.....
Dept. 3	2,349.95	3,219.46	3,527.78	4,555.02	2,131.17	.....
Dept. 4	1,115.20	1,769.93	2,709.23	1,397.20	1,243.10	.....
Dept. 5	454.76	98.33	482.05	229.86	152.02	.....
Dept. 6	3,023.10	2,345.91	2,759.09	3,889.46	3,391.90	.....
Dept. 7	7,919.71	9,881.38	8,410.23	8,954.38	10,641.59	.....
Dept. 8	919.20	3,640.71	3,505.93	5,253.94	6,557.24	.....
Dept. 9	6,123.99	6,702.45	14,203.04	11,824.40	18,013.47	.....
Dept. 10	32.44	114.82	1,108.38	1,138.17	228.18	.....
Dept. 11	965.13	3,423.14	1,410.00	2,941.49	3,505.01	.....
Dept. 12	447.69	3,073.85	315.91	794.90	344.29	.....
Total	$34,165.25	$44,393.18	$52,203.99	$52,666.22	$61,382.91	.....

Cost Analysis

These, together with a more or less detailed analysis of each, should constitute the bulk of the cost department's work. Much attention should be paid to the arrangement of data on the books so as to facilitate the preparation of such analyses as may be necessary from time to time to explain unusual fluctuations. It is much better to submit comparatively few summaries and to be prepared to furnish analyses of any of them quickly than to attempt the regular periodic compilation of many detailed statements.

The statement "Analysis of Repairs" is an example of a report gotten out upon request to explain an unusually large repair charge. That headed "Weekly Report of Construction" is a report for the use of the engineer on a construction job, which enables him to compare the amount of money spent to date on his work and the money appropriated to complete it. The "Laboratory Cost Sheet" is a monthly report to the chief chemist who may well be required to work under a budget; it includes all the expenditures for which he is responsible.

In presenting cost figures to the sales department month by month, one very general condition experienced is fluctuations in cost, due to the fact that repairs and other expenses are not incurred equally month by month. It is sometimes attempted to equalize such expenses by setting up on the books deferred charges, so that a very heavy expense is not charged to the operations going on in the month wherein the expense was incurred, but is spread over a period of several months, or even a year. Such a method as this leaves so much to the judgment as almost always to lead to confusion, and possibly also to embarrassment; no one likes to have deferred charges on his books. In my opinion, the better way is to charge all such expense to the operations when incurred, and to flatten out the cost figures by averaging them over periods of say six to twelve months. This would mean that in January the cost submitted would be the average of the past six months of the old year and the first one of the new, and so on until the end of the first six months of the year is reached, when the cost may become cumulative from the first to the end of the year.

The money spent on costs covering the ground indicated here need not exceed 0.5 per cent of the payroll; the difference between good management and the best possible is, I should guess, about 10 per cent. The one almost universal trouble experienced with cost departments and systems is their tendency to spend more

money on statistics than the use of the figures they submit can possibly save. Coupled with this is the tendency to attempt to turn out mechanically, month by month, large volumes of significant figures. The number of figures which a cost department is asked to produce each month should be cut down to the very minimum, and these should be only such as can be turned out by a mechanical routine and wherein as few elements of judgment enter as possible. Analysis beyond this point should be done by the technical staff of the plant, or by a department of cost analysis run, not by bookkeepers, but by men whose judgment is based on a real, solid understanding of the processes. The fewer and more simple the figures which the ordinary cost department run by bookkeepers and clerks with no operating experience and the greater the insistence that the technical staff of the plant take the figures, analyze and interpret them the more likely it is that valuable results will be obtained. An adding machine cannot think. It will say, for example, that a certain product is unprofitable; its manufacture, therefore, is discontinued. To your surprise, however, instead of saving the loss, a still greater loss is incurred. Shutting down the plant has not decreased outgo as much as it has decreased income. Depreciation, insurance, taxes, still continue; the plant begins to deteriorate and assets to drop; the overhead allotted to the plant cannot all be cut out and has to be carried by other processes. In general, the only safe way to determine whether a production shall be discontinued, increased or diminished is to disregard the individual cost figure, and to sit down and figure the effect the proposed change will have on the total income of the plant on the one hand and the total outgo on the other. Not until that is done can one be in a position to say whether the proposed change will result in greater profit, or in the least possible loss.

Chemists and Engineers Ought to Be Familiar With Accounting Methods

In the Philadelphia *Public Ledger* of Feb. 18, 1918, a statement was made in one of the editorials that 95 per cent of the businessmen of Germany are expert accountants. The continual association of values with materials and effort is an essential in the education of a successful chemical engineer. Of necessity it is omitted from his college training. The opportunity for doing it should be freely given in the industries.

The chemists and engineers in charge of our factories must be familiar with accounting methods. The economics of the factory must come within the scope of their activities. They must be able to use the help of the accountant. The officials of a corporation must be able to rely upon their technical men for sound advice, not only in the realms of physics and chemistry, but in economics also. Webster says that "economics is the art of regulating receipts and expenditures so as to insure a proper profit." Surely this is an art we need to acquire and not leave to a bookkeeping department.

What Otto Witt said in 1887 is truer than ever today: "The success of a process is no longer, as formerly, dependent upon the careful preservation of manufacturing secrets, but above all upon businesslike control, both within and without."

Chemical Department,
The Barrett Company,
Frankford, Philadelphia, Pa.

Development of the German Chemical Industry During 1919

A recently published report on the German chemical industry for the year 1919 contains some interesting data concerning the development of this important branch of industry.

The following figures show the number of plants in operation during 1919, and number of workmen employed:

District	Number of Plants	Number of Workmen, Full-time and Part-time	Decrease in Number of Full-time Workmen From Preceding Year., Per Cent
Berlin	2,518	68,393	7.31
Breslau	1,235	26,377	20.84
Hamburg	2,043	72,859	27.89
Cologne	2,562	121,537	31.85
Leipzig	2,648	125,559	12.04
Mannheim	1,325	50,615	12.80
Frankfort	1,081	51,198	2.70
Nuremburg	1,648	27,623	13.35
Total	15,060	544,161	18.18

From these figures it appears that the greater part of Germany's chemical plants are located in the Leipzig, Cologne, Berlin and Hamburg districts. There were 15,204 plants in operation in 1918, while the total had fallen to 15,060 in 1919, a decrease of 1.95 per cent. This decrease is due chiefly to the fact that the chemical plants in Alsace-Lorraine were eliminated from consideration in 1919. The number of working days credited to the 294,766 full-time workmen reached a total of 88,231,447 against 107,835,679 for 1918.

Wages Paid and Numper of Plants in Operation

The total amount of wages earned by workmen and employees in the chemical industry in 1919 amounted to 1,131,682,109 marks. If one uses as the basis of comparison the number of plants in operation, the number of full-time workmen, the wages earned, together with the annual compensation received, the figures for the single years during the period 1913 to 1919 show a generally upward trend.

Year	Number of Plants	Number of Full-time Workmen	Total Amount Wages Paid, Marks	Average Annual Compensation of Full-time Workman, Marks
1913	15,042	227,629	351,520,206	1,266
1914	15,014	245,980	313,508,108	1,273
1915	14,914	219,646	295,217,251	1,344
1916	14,998	256,420	382,783,261	1,493
1917	15,129	334,851	652,877,501	1,950
1918	15,204	360,256	889,141,025	2,468
1919	15,060	294,766	1,064,782,786	3,612

A slight decrease is to be observed in the number of plants in operation during the period 1914 to 1916. In 1917 the number of plants was larger than for the year 1913, and the increase continued in 1918. In 1919, however, there occurred the slight decrease previously noted. The number of full-time workmen employed in 1919 exceeded by 17,000 the number employed in 1913. The year 1918, with its total of 360,256, marks the high-water point in full-time workmen employed.

It is interesting to observe that compared with 1913 the amount of wages received in 1919 has tripled. The highest point in the total wages paid was reached in 1919. Hand in hand with this growth went the increase in the average annual compensation of the full-time workman. In 1913 this figure amounted to 1,266 marks, while in 1919 it had risen to 3,612 marks. Everything points to a heavy increase in the 1920 average against that of 1919. In the course of the present year workmen in the chemical industry have been paid such amounts as would indicate that the average annual wage might reach a total of 18,000 marks or even more.

Pulp and Paper Production in Quebec, Canada, During 1919

The total quantity of lumber cut in the province was 814,455,900 ft. b.m., as compared with 931,462,800 ft. in 1918. In 1919 there were sixteen pulp mills in Quebec Province, with an aggregate daily production of 1,300 tons, and twenty-seven combined pulp and paper mills producing 1,600 tons of paper daily. A conservative estimate gives the year's production of pulp of all kinds as 800,000 tons and of paper and paper products as 450,000 tons, the greater part of the pulp being consumed in the manufacture of paper within the province. The selling value of the entire output was $65,000,000, an increase of $13,294,217 over the figures of 1918 and of approximately $23,000,000 over those of 1917. Most of the products are sold in the U. S.

Reconstructing French Chemical Industry

France has made notable progress in setting her chemical industry on its feet again. The 17 per cent of the chemical plants of all kinds in France which were located in the devastated departments were almost entirely destroyed. The departments of the Nord and of the Aisne suffered particularly, supporting 70 per cent of the total damage, which is estimated according to 1914 values to be 128,840,208 francs.

The Ministry of Liberated Regions, which has taken a census of the various plants that can be classed under the heading "chemical industry," announces that on Oct. 1, 1920, 111 out of 142, or 78.1 per cent, had resumed operation wholly or in part. The greatest proportion in resumption of operation is found in the Lille region (89.3 per cent). These 142 plants in 1914 employed 21,210 workmen. On Oct. 1, 1920, 54.2 per cent of this number, or 11,512, were employed in production. The nearest approach to normal is found in the Department of the Meurthe et Moselle. A year ago, or on Oct. 1, 1919, only 18.7 per cent of the 1914 personnel was occupied at production. Since that date there has been a steady increase, the proportion from Jan. 1, 1920, increasing from 34.7 per cent to 54.2 per cent above mentioned.

The production in 1914 of the plants which can be classed under the heading chemical industry proper was estimated at 850,000 tons. The present production is between 200,000 and 300,000 tons. Under this heading are included plants manufacturing sulphuric acid, nitric acid, hydrochloric acid, sodium sulphates, iron, copper, sulphites, superphosphates, ammonium salts and various fertilizers. No figures are yet available on the production of chemical byproduct factories, either for 1914 or at present. Under this heading are classed all factories which handle chemical products already prepared, such as salt refineries, the preparation of sodium crystals, hypochlorites, pharmaceutical and hygienic products, photographic materials, etc.

The chemical industry in general throughout France has received great encouragement as a result of the war. Prior to 1914 the industry was of relatively minor importance, French manufacturers preferring to import the necessary supplies from Germany, which for years had specialized in this branch of industry. However, once the German supplies were cut off and the war showed the immense value of chemicals in the successful prosecution of hostilities, the French Government and private enterprise began to turn their attention seriously to the development of the industry in France. The manufacture of powder, which is an important branch of the industry, is in the hands of the government, it being, with tobacco, matches, etc., a government monopoly. It will only be necessary to cite a few figures on this one product to show what preeminence the chemical industry attained in the eyes of the French General Staff. The plan of French mobilization in 1914 included the following estimates:

Quantity of powder to be produced during the war, 24 tons a day.

Quantity of other explosives to be produced during the war, none.

No one then supposed that the quantity of explosives on hand would not be sufficient for any war purposes. However, after the first battle of the Marne, the pressing need of chemicals for powder and explosives began to develop. It was necessary to create factories almost over night to meet the ever-growing demands of the army. The original provisions, cited above, were doubled many times over, so that by June 25, 1917, the estimates of army needs were the following:

Quantity of powder to be produced, 640 tons a day.

Quantity of other explosives to be produced, 1,100 tons a day.

All this productive capacity, no longer needed for war purposes, can be utilized to build up the chemical industry to a position where France will be independent of foreign sources of supply.

Clay Storage Within the Factory

The December issue of the *Journal of the American Ceramic Society* contains an original article by T. W. Garve, embodying the essentials of adequate storage space and material-handling equipment within the factory, with numerous sketches to illustrate definite layouts.

"To insure continuity of operation it is necessary to have a supply of crushed and ground shale or clay on hand to bridge over breaks and delays and to keep the machinery running ahead of the bin. It is well for the superintendent, and for the men, to know in the morning that there is enough clay supply on hand within the factory to see the day through for production. Besides, any further handling and storing of clays will improve the quality of the clay by intermixing of the particles and their exposure to air.

"Bins employed for such purposes are usually built overhead. This will put the storage out of the way and allow for passage below and for the installation of feeders at the bottom for continuous and automatic feed to the grinding or pugging machinery.

"For delivering raw shale or dry lumpy clay to the factory it is well to dump the contents of the car into a pocket at the bottom of which a plate feeder is operating to insure a steady uniform charge of material to the crusher (or dry pan).

"If a crusher is used ahead of the dry pan, it is proper to place a storage bin between them for keeping crushed material on hand. The crushed material can be fed out of such a bin by means of a reciprocating plate feeder as before or by a disk feeder. The ground material should be stored again above the pug mill with a disk feeder to permit of fine adjustments."

The principles covered in this paper involving storage capacity for raw material and product of machines may well be applied to chemical plants where considerable material is involved in the daily operations.

Nickel Brasses

A Summary of the Work of Leon Guillet Published in "Revue de Metallurgie" of 1913 and 1920 on the Important Role Played by Nickel in the Manufacture of Low-Copper Ternary Brasses

AS A RESULT of a systematic study of special brasses[1] it appeared that only nickel, iron and manganese, of several other elements, raised the "fictitious composition" of the ternary alloy. That is to say, whereas most of the alloying elements acted as though they replaced zinc, these three seemed to replace copper. Nickel was much the most powerful in this action, and it appeared desirable to investigate these alloys in detail[2] in the hope that desirable commercial alloys might be discovered. Theoretical considerations expounded in the former articles[1] led to the expectancy of alloys which could be hot-worked, even though very low in copper, and cold-worked, though relatively low in copper. With approximately normal copper, a little nickel would doubtless increase the elongation, and therefore the ease in cold-working, drawing or stamping. It can readily be seen that if a cheap addition metal could be discovered whose coefficient of equivalence were sufficiently small, a very much cheaper alloy might probably displace the ordinary brasses.

Coefficient of Equivalence

Four series of alloys were studied, of 50 and 55 per cent copper, sand- and chill-cast respectively. In each it was desired to replace successively 0.5, 1.0, 2.0, 5.0 and 10.0 per cent of the zinc by nickel. Virgin metal of highest purity was used, so that the resulting bars analyzed only traces of tin and lead. Actual contents of copper, nickel and iron are tabulated.

To determine the coefficient of equivalence the 55 per cent copper brasses of Series I (Table I) were selected. Since t had previously been determined[1] to be less than 1, if one started at the upper limit of β a little nickel would give microscopic field of $\alpha + \beta$. Experimentation quickly indicated that annealing the castings at 750 deg. C. for two hours was necessary in order to normalize the structure and permit accurate microscopic analysis.

As seen in the table, t, the coefficient of equivalence, lies between —1.1 and —1.4, —1.2 being the average. Series II, of practically the same analyses, cast in sand, gives limits and average (—1.4) slightly higher. On the whole, —1.3 seemed to be the most probable value. Series III and IV were available to check this figure, which, within the available limits, was quite close. See especially alloys Nos. 16 and 22. Nos. 17 and 23 are good, considering the high amounts of nickel present.

Alloy 21 (Cu 49.52, Ni 2.28) gives a single microscopic constituent, whether a raw casting or annealed. It is notable, however, that it develops a coarsely polyhedric grain on reheating following no working of any kind, a phenomenon long regarded by many metallurgists as extremely rare if not impossible. Fig. 1, alloy 23 after annealing, shows the β constituent clearly in a fine eutectoid, a structure never found in ordinary brasses.

Mechanical Tests

All the melts described were subjected to the ordinary static tension and Brinell test. Impact results on notched specimens are also tabulated in Tables I to IV inclusive. Hardness was determined on unannealed castings. The figure for elastic limit is doubtful in almost all cases on account of the well-known difficulty in determining the limit of proportionality in brass specimens. Contraction is also difficult to measure on account of irregularities in the necked area.

Effect of Nickel on 50 and 55 Copper Brasses

Inspection of the tables shows that nickel betters the mechanical properties of these brasses if the fictitious composition is sufficiently high. Especially in the 50 per cent copper brasses, Alloys Nos. 15 and 21 (2 per cent nickel) show a very great increase over similar melts containing half as much. Five per cent nickel gives an even greater advantage, while the 10 per cent nickel alloys are quite remarkable.

Comparison of alloys 16 and 22 with Nos. 6 and 7 shows that in general the properties of the ternary alloys correspond fairly well with those of a real alloy having a composition approximating the fictitious composition of the former. However, the important specific effect of nickel can be seen most notably in increasing the strength. Alloys of the same fictitious composition, yet containing widely varying amounts of nickel, will for the same reason also show variations in properties; compare alloys 2 and 22. For this reason, predictions based upon microscopic study and fictitious compositions

FIG. 1. SAND-CAST ALLOY NO. 23. 49.13 Cu, 10.07 Ni. × 60.

[1] *Revue de Métallurgie*, Memoirs, 1905, p. 97, and 1906, p. 242. Summarized in CHEMICAL & METALLURGICAL ENGINEERING, vol. 24, No. 4, p. 177, Jan. 26, 1921.

[2] *Revue de Métallurgie*, Memoirs, 1913, vol. 10, p. 1130.

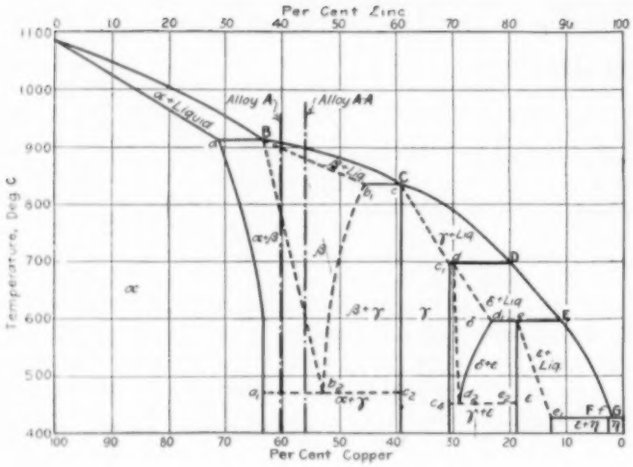


FIG. 2. EQUILIBRIUM DIAGRAM FOR COPPER-ZINC ALLOYS
After Gulliver, "Metallic Alloys," p. 267

must be made with circumspection and a good knowledge of the effect which the third element will exert by its own right.

Yet it could be expected that since nickel increases the elongation of brasses relatively low in copper, a brass with a little nickel could be worked or drawn better in the cold, an expectation abundantly verified in practice. Again, if nickel be added to a binary brass which can be worked hot and whose constitution is $\alpha + \beta$, but nearly all α (say a 62:38 brass), all the β is suppressed and it may be rolled hot only with difficulty. This change may be much intensified in commercial production, owing to the temptation of remelting nickel-plated ware whose base might be anything, thus introducing many unknown impurities into the mixture. Inspection of the table shows that remarkable strength, ductility and toughness are had in 49:41:10 alloys[3] but more especially in 54:41:5 (alloy No. 10). Rolled and annealed metals of composition 55:43:2 and 50:45:5 were found to have ultimate strengths of from 64,000 to 71,000 lb. per sq.in., an elongation of from 33 to 45 per cent, resiliency of 10 kg.-m. on grooved 10 x 10-mm. test-piece, and Brinell hardness of 100. The war stopped researches along these lines, and the first commercial production of 55:43:2 appears to have been undertaken in the United States. However, even before the war the following results were obtained in French practice:

	Analysis		Analysis
Type A		Type B	
Cu	56.7	Cu	55.15
Zn	39.74	Zn	42.3
Ni	3.35	Ni	2.24
Pb	0.0	Pb	0.0
Fe	0.12	Fe	0.09
Mn	0.05	Mn	tr
Al	tr	Al	0.05
Sn	tr	Sn	tr
Microscopic Cu	60.5	Microscopic Cu	58.0
Calculated ($t = -1.3$)	61.5	Calculated ($t = -1.3$)	58.4

	A		B	
	Casting Annealed 2 Hr. at 750 Deg. C.	Cold-Drawn Bar	Casting Annealed 2 Hr. at 750 Deg. C.	Cold-Drawn Bar
Ultimate strength	67,200	75,900	64,800	72,400
Elastic limit	21,800	50,200	20,200	37,600
Elongation	43.0	33.3	33.0	29.0
Contraction	51.7	50.7	[4]	[4]
Impact strength	18.1	14.8	12.9	9.3
Brinell hardness	97	144	116	151

[3]Copper analysis given first, then zinc, then nickel.
[4]Unknown, but very great.

TABLE I—SERIES I. CHILL-CAST BRASSES WITH 55 PER CENT COPPER

Alloy No.	Chemical Analysis			Microscopic Analysis	Calculated	Tension Tests				Brinell Hardness	Impact Resistance*
	Copper	Ni	Fe	Copper	t	Ultimate	Elastic Limit	Elongation	Contraction		
1	55.10	0.59	0.23	55.7	— 1.1	58,800	20,800	14.0	...	113	11.2
2	55.14	1.02	0.13	56.5	— 1.4	36,300	18,900	6.0	...	139	9.4
3	55.95	2.03	0.14	58.5	— 1.2	46,700	19,900	12.0	...	113	11.2
4	55.41	5.02	0.15	62	— 1.1	50,600	19,300	27.0	...	90	13.5
5	54.62	10.57	0.17	> 63	.....	41,400	19,300	37.00	...	79	8.1 to 14.3

TABLE II—SERIES II. SAND-CAST BRASSES WITH 55 PER CENT COPPER

Alloy No.	Chemical Analysis			Microscopic Analysis	Calculated	Tension Tests				Brinell Hardness	Impact Resistance*
	Copper	Ni	Fe	Copper	t	Ultimate	Elastic Limit	Elongation	Contraction		
6	55.17	tr	0.05	55	.....	49,200	.....	13.0	...	126*	10.0 to 14.3
7	54.37	0.61	0.06	55	— 1.5	58,500	.....	17.0	...	140*	10.6 to 16.2
8	54.19	1.23	0.06	56.0	— 1.5	55,200	.....	13.0	...	140	10.6 to 13.1
9	54.37	2.31	0.06	57.5	— 1.4	57,400	.....	19.0	...	119	8.7 to 12.5
10	53.85	5.14	0.06	59.5	— 1.1	54,800	.....	46.5	...	94	10.6 to 14.3
11	54.13	9.87	0.11	> 63.0	.....	.....	.....	....	...	....	7.5 to 4.5

TABLE III—SERIES III. CHILL-CAST BRASSES WITH 50 PER CENT COPPER

Alloy No.	Chemical Analysis			Microscopic Analysis		Tension Tests				Brinell Hardness	Impact Resistance*
	Copper	Ni	Fe	Found	Calculated	Ultimate	Elastic Limit	Elongation	Contraction		
12	49.26	.....	0.08	....	.....	23,600	.....	1.0	1.5	163	1.8 to 2.5
13	49.46	0.50	0.07	> 54.7	49.9	26,500	.....	1.5	...	151	1.8 to 2.5
14	49.17	1.00	0.10	> 54.7	50.3	26,100	.....	3.0	4.5	129	2.5 to 5.0
15	49.47	2.02	0.11	> 54.7	51.8	55,600	.....	12.5	...	143	5.0 to 6.8
16	49.48	5.02	0.39	55.5	55.9	60,200	.....	10.0	8.0	153	7.5 to 9.3
17	49.24	9.81	0.39	62	63.5	54,900	.....	23.5	...	112	14.3 to 15.0

TABLE IV—SERIES IV. SAND-CAST BRASSES WITH 50 PER CENT COPPER

Alloy No.	Chemical Analysis			Microscopic Analysis		Tension Tests				Brinell Hardness	Impact Resistance*
	Copper	Ni	Fe	Found	Calculated	Ultimate	Elastic Limit	Elongation	Contraction		
18	49.21	.....	0.08	....	.....	16,500	.....	....	...	156*	1.8
19	49.08	0.62	0.06	> 54.7	49.5	19,900	.....	1.5	1.5	151	1.8 to 2.5
20	49.23	1.16	0.11	> 54.7	50.6	23,600	.....	2.5	4.5	138	2.5 to 3.7
21	49.52	2.28	0.10	> 54.7	52.2	47,000	.....	11.0	...	146	5.0 to 10.0
22	49.41	5.15	0.17	56.2	56.0	56,400	.....	9.0	...	143	8.7 to 12.5
23	49.13	10.07	0.31	62	63.8	50,500	.....	42.0	...	89	15.6 to 19.3

* Kg.-m. on notched 10 x 10-mm. test-piece.

TABLE V. SERIES V. HIGH-NICKEL BRASSES

Alloy No.	Chemical Analysis Copper	Chemical Analysis Nickel	Microscopic Analysis Copper Calculated	Microscopic Analysis Copper Observed
24	50.32	4.15	55.5	55
25	50.34	6.70	59.4	59
26	45.32	8.34	55.9	β
27	46.35	10.35	60.6	58
28	46.03	12.56	64.6	62
29	40.25	12.87	56.9	β
30	40.46	14.42	60.4	57
31	41.10	16.54	66.1	62
32	36.15	17.70	60.9	56
33	36.18	19.58	65.4	59
34	36.26	21.82	72.4	62
35	35.86	23.49	77.4	α
36	30.57	22.70	63.8	56.5
37	25.01	24.81	58.1	β
38	25.74	27.76	70.8	56.5

When next approaching the study of these brasses,[5] it appeared desirable to discover whether the properties of a 50:45:5 brass (strength, toughness, incorrodability and pleasing color) could be had by decreasing the copper and increasing the nickel.

A series of test-pieces of the compositions given in Table V were prepared, attempting to add nickel in such proportions as to maintain the fictitious compositions between about 55 and 58 per cent.

Fictitious compositions of the alloys formed of $\alpha + \beta$ constituents were determined microscopically to within 0.5 per cent and results tabulated. It is evident that there are important differences between the fictitious compositions when determined microscopically and calculated. Calculating back with the formula

$$t = 1 + \frac{100}{q}\left(\frac{A - A'}{A'}\right)$$

it is found to vary between —0.9 and —1.2, the smaller when the copper content is lower.

It may be noted that the color of the alloys is as follows:

Alloy No.	Color
24	Pale gold
25	Pale gold
26	Yellowish white
27	White and yellow, changeable
28	White and yellow, changeable
29	Silver white

Rolling Tests

To discover the possibility of forging and rolling, tests were made on all brasses under the same conditions—namely, temperatures of 650 to 750 deg. C., same rolling mill and passes at same velocity and pressure, starting with 80-mm. diameter ingots and ending with 20-mm. round bars.

The results obtained in rolling tests are noted in Table VI.

TABLE VI. ROLLING TESTS ON HIGH-NICKEL BRASSES

Alloy No.	Results
24	Easy to roll and without defects
25	Easy to roll and without defects
26	Very difficult to roll. Cracked
27	Easy to roll without defects
28	Difficult to roll without defects
29	Difficult to roll without defects
30	Easy to roll without defects
31	Small cracks when rolled
32	Cracks badly from start
33	Breaks in pieces from the start

Alloys 27 and 30 appeared worthy of thermal investigation, since they have unique ductility when hot. There should be an intimate relation between the correct temperature for forging, the transformation temperatures and variations in mechanical properties. Their microstructure is given in Figs. 3 and 4.

The alloys tested and the results obtained are given in Table VII. Fusion points have been determined with the Coste apparatus; transformation points with the Saladin-Le Chatelier double galvanometer.

While the transformation points in the ternary brass approximate those of binary alloys with the former's fictitious composition, it is evident that these temperatures are raised by nickel, but the elevation is not directly proportional to the nickel content.

TABLE VII. THERMAL ANALYSIS

Alloy No.	Chemical Analysis Cu	Chemical Analysis Zn	Chemical Analysis Ni	Microscopic Analysis Cu	Liquidus	Solidus	Transformation Points On Heating	Transformation Points On Cooling
27	46.35	43.16	10.35	58.5	..	....	660-810	760-660
30	40.46	44.95	14.42	57	..	....	470-730	730-375
..	60	40	.....	.....	890	875	445-780	740-450
..	55	45	.....	.....	875	850	445	450
..	46	54	.....	.....	850	840	450	450
..	40	60	.....	.....	840	840	470	450

Effect of Added Metal

In a general way when a third element is added to a copper-zinc alloy the following may take place:

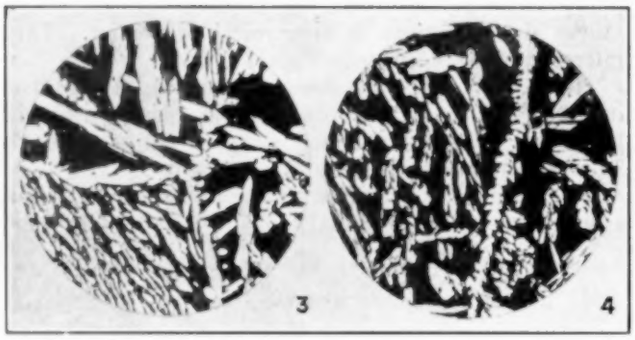
(*a*) A special constituent may be formed, consisting of the isolated added element, or of a combination of this element with copper or zinc, or of a new solid solution. For instance, lead appears as a special constituent (rounded globules) when present to the extent of 1 per cent or more.

(*b*) The eutectoid point may be displaced to the right or to the left, creating a fictitious composition when determined microscopically, which may be respectively above or below the copper content of the actual chemical analysis. It has already been shown that aluminum, tin, silicon and magnesium, having a coefficient of equivalence for zinc greater than 1, move the β eutectoid (point b_2 in Fig. 2) to the left and at the same time the brass assumes a fictitious composition in copper less than the real. On the other hand, iron, manganese and nickel, having $t<1$, move b_2 to the right, and the fictitious copper content is higher than shown by chemical analysis.

(*c*) The eutectoid point may be displaced not only horizontally but vertically—i.e., the eutectoid horizontal may be lowered or raised. In this case extremely important variations from the normal constitution of the fictitious binary alloy may result. In a general way, if the point is sufficiently lowered (probably to about 350 deg. C.) the structure after slow cooling becomes martensitic. Such a phenomenon is indicated by Robin's work on bronzes, and by the structure of many special steels. If the transformation point was lowered to below ordinary temperature, the structure would be polyhedric (austenitic in steels). If, on the contrary, we consider a non-resolved eutectoid—as is the case for brasses—and the added element raises the eutectoid temperature, the two constituents of the eutectoid will have opportunity by time and high-temperature mobility to coalesce and appear, especially when the rise in temperature is sufficiently important.

Data on thermal analysis given in Table VII show one important rise in the location of the eutectoid temperature; whereas for normal brasses this transforma-

[5] *Revue de Métallurgie*, July, 1920, p. 484.



FIGS. 3 AND 4. BRASSES NOS. 27 AND 30 RESPECTIVELY, SHOWING GREAT DUCTILITY

tion on cooling takes place at 450 deg. C., when 10.35 per cent nickel it occurs at 660 deg. C.

In a slowly cooled sample of alloy 27 or 28 one would therefore expect to see both the α and γ constituents under moderate magnification, an expectation confirmed by Fig. 5.

This has already been noted by Carpenter. Further studies to be described later show that the resolved eutectoid appears under circumstances which can be predicted if the rise of the transformation point is known. This is a very remarkable fact from the point of view of the general theory of hardening.

Mechanical Properties at Ordinary Temperature

Tests were made on cast and rolled metals as shown in Table VIII, determining the ultimate strength, elastic limit, per cent elongation after breaking, contraction (which is defined by the relation $\frac{S - s}{S} \times 100$), impact strength of notched 10 x 10-mm. bar, and hardness. For tension tests the pieces were 13.8 mm. diameter (0.54 in.) and 100 mm. (3.94 in.) between punch marks.

The alloy which has the most remarkable mechanical properties is the No. 27 (Fig. 3), analyzing 46.3 per cent Cu and 10.3 per cent Ni, but it possesses a yellowish glint, and this might be a hindrance for some uses.

Alloy No. 30, 40.4 per cent Cu and 14.4 per cent Ni (Fig. 4), is of an exceptionally white color and has very interesting mechanical properties.[6]

From the study of the data it can be seen: First, that if we consider the relations between fictitious compositions and mechanical properties, the most interesting alloys are those whose fictitious compositions lie between 57 and 60 per cent. It is well to remember that this is also the case for the binary brasses which give relatively high value in this range (ultimate 46,000 to 54,000 lb. per sq.in., and elongation 35 to 40 per cent).

Second, there are a number of alloys which present the microscopic aspect of ordinary brasses ($\alpha + \beta$) and which do not have any interesting properties. This is a new fact which has not been brought out in previous tests on special brasses, due perhaps to the fact that the work was not done on sufficiently various compositions. An instance is Fig. 6 of alloy 36.

There is no question that when nickel is sufficiently high it alters the properties of the solid solutions considerably, or at least of the β solution, which becomes extremely fragile (alloy No. 37; see also Table V).

TABLE VIII. PHYSICAL PROPERTIES OF CAST AND WORKED BRASSES

		Tensile Tests				Stock Tests		
Alloy No.	Condition	Ultimate Strength	Elastic Limit	Elongation	Contraction	Strength	Angle of Rupture	Brinell Hardness
24	Cast	52,500	28,500	9.0	14.2	5.6	167	143
	Rolled	62,600	29,900	9.0	49.7	9.5	149	151
	Cold drawn	81,000	.....	4.0	11.5	6.2	162	197
25	Cast	62,900	23,600	31.0	44.3	7.5	149	109
	Rolled	72,000	25,100	46.5	14.2	11.3	144	118
	Cold drawn	82,600	.....	27.5	50.7	7.5	160	176
26	Cast	27,300	28,200	0.5	1.4	1.8	180	160
	Rolled	49,800	36,000	3.0	3.1	2.5	180	156
27	Cast	68,700	26,900	31.0	30.7	11.0	151	128
	Rolled	80,600	36,700	45.0	57.5	13.2	142	137
	Cold drawn	101,800	19,900	....	22.0	5.0	172	207
28	Cast	54,000	34,200	17.0	11.5	9.7	146	121
	Rolled	67,200	32,700	49.0	52.7	13.7	135	116
29	Cast	7,000	.....	1.0	....	....	....	159
	Rolled	43,200	40,200	1.0	1.4	1.5	180	170
30	Cast	91,700	57,000	7.0	10.1	4.3	168	190
	Rolled	86,500	44,500	18.5	19.4	7.8	166	170
31	Cast	92,500	81,100	....	....	2.5	179	255
32	Cast	72,300	54,900	2.5	4.5	3.0	173	191
	Rolled	77,200	51,200	5.5	7.3	5.0	178	187
33	Cast	90,000	71,000	2.0	3.1	3.1	178	217
34	Cast	77,600	77,600	1.0	0.0	2.5	179	241
35	Cast	93,600	93,600	1.0	0.0	2.1	177	262
36	Cast	35,400	21,200	0.0	0.0	1.2	179	210
37	Could not be machined into a test piece					....	....	....
38	Cast	8,500	8,500	0.0	0.0	1.2	179	228

Influence of Cold-Drawing

It is evident that the brasses which can be rolled could also be cold-drawn if they possess sufficiently high elongations. But it is to be noted that the greater part of these alloys having a high ultimate strength also possess a high elastic limit—at least higher than those of ordinary brasses—and, due to this fact, the speed of drawing has to be small.

In general, it is not easy to determine the elastic limit.

Table VIII also shows the influence of drawing on the mechanical properties of three of the alloys. The figures have been obtained after one draw on a 20-mm. (0.79-in.) round bar, reducing it 2 mm. (0.08 in.) in diameter.

Influence of Lead

It is known that lead greatly facilitates working ordinary brasses and that all the alloys for machine-finishing contain from 1 to 3 per cent lead. As noted

[6]The alloys containing less than 50 per cent of copper have been patented by the Société Métallurgique de la Bonneville.

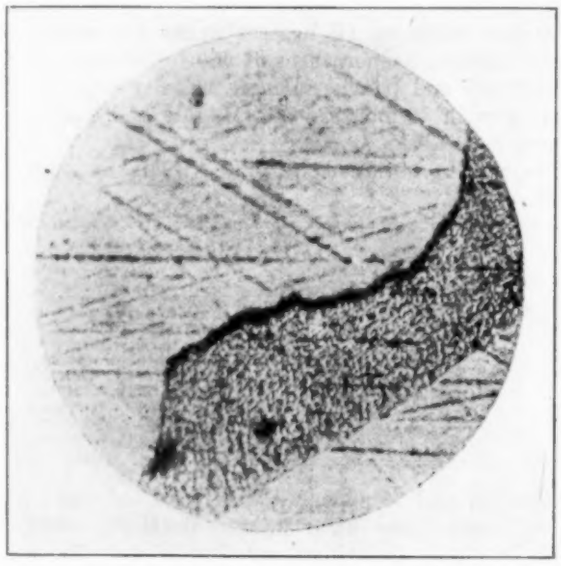


FIG. 5. SLOWLY COOLED BRASS CONTAINING 46.0 Cu, 12.5 Ni

TABLE IX. EFFECT OF LEAD ON NICKEL BRASSES

Alloy No.	Chemical Composition				State	Tension Tests				Impact Test		Brinell Hardness
	Cu	Ni	Pb	Zn		Ultimate Strength	Elastic Limit	Elongation	Contraction	Strength	Angle of Rupture	
39	50.55	6.55	0.18	42.57	Rolled	57,700	.....	41.0	43.3	11.3	142	141
40	49.65	6.72	2.25	40.96	Rolled	67,300	.....	30.0	29.5	7.5	156	135
41	44.70	10.90	0.16	44.07	Rolled	78,200	.....	31.0	30.7	8.1	158	168
42	44.80	10.96	2.23	41.70	Rolled	74,000	.....	35.0	41.1	5.6	161	132
43	39.64	14.38	0.21	45.56	Rolled	78,200	.....	6.0	8.7	4.4	172	181
44	45.2	10.2	1.0	.....	Cast	61,700	27,200	14.0	15.5	5.3	160	127
					Rolled and annealed	77,200	29,900	41.0	36.6	10.6	152	137
45	45.3	10.3	2.0	.....	Cast	53,400	26,500	11.5	11.5	4.4	166	117
					Rolled and annealed	73,700	30,700	45.5	42.2	9.4	152	126
46	45.4	10.4	3.0	.....	Cast	54,000	24,600	26	22.0	5.3	167	107
					Rolled and annealed	70,000	31,300	50.5	48.6	9.4	156	119
47	45.1	10.4	4.0	.....	Cast	59,600	25,000	30.0	15.5	4.4	169	105
					Rolled and annealed	64,900	30,300	26	24.7	5.9	158	112

above, this element retains its individuality in the alloy, forming an inclusion which renders the turnings more fragile and less harmful to the edge of the tool. However, this isolated lead lowers other mechanical qualities of the alloy.

Alloys starting with 45 Cu, 45 Zn, 10 Ni were tested, with which 1, 2, 3 and 4 per cent of Pb were substituted for zinc. Microscopical examination showed the presence of globules in quantities increasing with the lead content.

From the inspection of Table IX one might think that some results have been confused, but this is not the case, and the tabulated figures have been verified with the greatest care. It can be seen that lead up

FIG. 6. BRASS NO. 36 (Cu 30.6, Ni 22.7). × 200

to 3 per cent is in reality quite harmless to the mechanical properties of the alloys. Compare especially alloys Nos. 44, 45, 46 and 47 with alloy No. 27.

Divergence Between the Properties of an Alloy When Rolled and When Cast

Special attention is called to the pronounced divergences between the properties of the alloy when rolled and when cast. This is due to the fact that the reheating followed by mechanical work renders the microstructure of the metal more homogeneous.

No particular difficulty has been noted in the rolling of these alloys; it was as easy as the same operation on products not containing lead. But when the original alloys are rolled with difficulty, or when the elongation is low, especially alloy No. 30 (40 Cu, 14 Ni), the addition of lead lowers these properties even more and the products obtained clearly show fissures even after the first pass. Thus the alloy 41.52 Cu, 14.48 Ni, 2.25 Pb, 14.48 Zn could not be rolled.

Machining Qualities

Appreciation of the machining qualities of a metal varies from shop to shop and even from machinist to machinist.

A series of opinions on alloys of the three types 50:44:6, 45:45:10 and 40:46:14 collected from different plants proved that these alloys can easily be machined in all cases, although not as easily as ordinary brasses. The presence of lead undoubtedly facilitates the machining; the chips in this case are short and easily separated from the tool.

Variation of the Properties With Variations in Temperature

Some alloys were studied at high temperatures which had been found to be quite difficult if not impossible to roll.

It resulted that the hardness diminishes rapidly as the temperature increases, reaching a value of about 50 at 500 deg. No reliable results could be obtained for temperatures above 700 deg. C.

Variations in resiliency are much more interesting and the harmful influence of lead is very marked. In alloys without lead the resiliency is increased remarkably at about 700 to 800 deg. C. (from about 2 kg.-m. to about 9), and it can be surmised that such alloys might be rolled if it were done at between 700 and 850 deg. C.—i.e., at a temperature higher than that used for brass. This fact has also to be taken into consideration when stamping nickel brasses. High-lead samples showed little change in impact-strength with temperature.

Conclusions

The results indicate the great value of nickel in the manufacture of low-copper brasses. From the industrial point of view, this study describes some alloys of exceptional qualities possessing ultimate strength up to 90,000 lb. per sq.in. with 20 per cent elongation and a resiliency of 8 to 10 kg.-m., very interesting variations in color from white to gold yellow, and a high resistance to atmospheric corrosion.

It can be expected that nickel is destined to play the same important rôle in the manufacture of copper alloys as it does in that of steels.

It is to be noted, however, that brasses with very high nickel contents can exhibit good microstructure ($\alpha + \beta$), yet not have any valuable special property.

Ownership of Highways and Streets

By Chesla C. Sherlock

RECENT press dispatches contain a very interesting account of a dispute between the Nichols Copper Co. and the Borough of Queens in New York City over the ownership of a street running through the factory grounds. The press account states:

"The disputed street is about ten blocks long and extends from Creek St. to the Newtown Creek waterfront. The Nichols company owns the land on either side and its property is partly improved and partly a place for the storage of coal. Down the middle of the street runs the narrow-gage plant railway and it is fringed with heaps of old iron, lumber and other materials. Residents of the Newtown section, complaining that access to the waterfront was denied them, besought Borough President Connolly to do something."

As soon as Mr. Connolly was advised that the company was putting up iron gates across the street to shut out the public, he gathered a force of 100 borough laborers and proceeded to tear up the railway and to clear the street of débris, claiming that it belonged to the city. There was no clash, the company contenting itself with court action and giving notice that the borough would be held responsible at law for all damage done to what it claims to be its private property.

There is probably no subject which has called for as much attention from the courts as that of the ownership of streets and highways.

Test of Ownership of a Way

The test of the ownership of a way, according to Ruling Case Law and backed up by numerous decisions of the courts, "is whether it is an open public way or one for the exclusive benefit of an individual or certain individuals. It is the right of travel by all the world, and not the exercise of the right, which constitutes a way a public highway, and the actual amount of travel upon it is not material. If it is open to all who desire to use it, it is a public highway, though it may accommodate only a limited portion of the public or even a single family, or though it accommodates some individuals more than others. Giving a private way a name, however, does not make it a public highway or thoroughfare."

This expression may be said to lay down the general principles governing in general cases. Seeking to apply it to the facts in any particular case, however, it is necessary for us to delve still deeper into the law.

Highways generally are established in two ways: First, by affirmative act under a statute giving that right; second, by long-continued usage as such. The latter principle applies in most jurisdictions; in some it is expressly abrogated by law.

It is quite apparent that the street in controversy had been used as a public way by some of the Newtown residents and that the company gradually assumed control of it for private purposes, at last attempting to shut out the public entirely.

How Streets May Be Discontinued

Streets may be discontinued at law only by abandonment. This does not mean by simply ceasing to use them, but it means by the affirmative act of publicly abandoning them.

There is a maxim in highway law which reads, "Once a street, always a street," and it holds good unless the street is legally discontinued by the method prescribed in the statute relating to such matters.

In a New York case, it was held that a street was not discontinued or destroyed where an abutting property owner constructed a wharf upon said street.

In a Rhode Island case, which seems to be squarely in point with the borough case mentioned above, it was shown that a riparian owner had platted his land into streets, lots, squares, one of such streets being below high-water mark; the street was subsequently filled out, and the adjoining lots were sold to another party, who sought to use the street for private purposes just as the Nichols company attempted to use the street mentioned above, and not only that, but this owner attempted to close the street to the public. The court held that "the fact that the title to the several lots over which the highway runs becomes vested in the same owner does not extinguish the way, or justify such owner in closing it up, where it is appurtenant to other lots, as when it leads from other lots to tidewater."

In this Rhode Island case it was held that one lot owner had the right to keep that street open in the name of the public, because the closing of it cut him off from the waterfront.

Private individuals or private companies have no right to obstruct public ways, to lay tracks upon them or to close them up, except by express grant from the public. In case of the discontinuance of a public way, it cannot be assumed or inferred from the fact that it is seldom used by others than those owning property on both sides of the street; it can be a fact only by the affirmative act of the public in the method set out by law.

United States Has Over One-Quarter Million Producing Oil Wells

According to the figures compiled by the United States Geological Survey there were 258,600 oil wells in the United States with an average daily production of 4.98 bbl.

Pennsylvania ranked first in number of wells (67,600), but lowest in average daily production (0.3 bbl.); Oklahoma followed next with 50,700 wells with an average daily production of 6 bbl. Texas, Louisiana, California and Wyoming and Montana, although possessing fewer wells, had a greater daily average production, of 27, 31.8, 32.3 and 55 bbl. respectively.

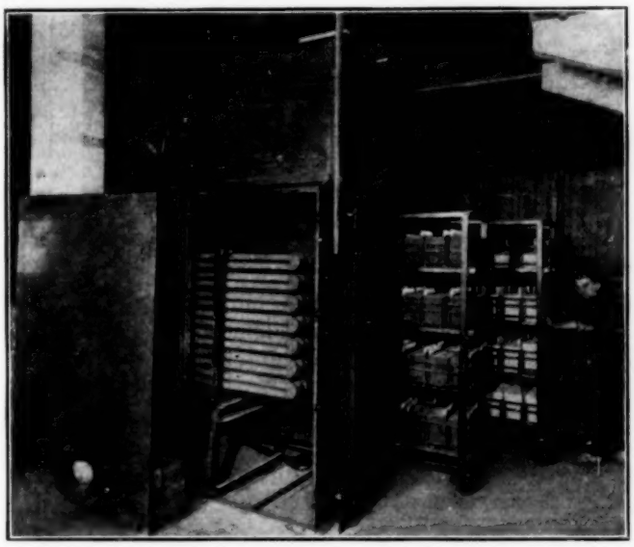
The following table gives the district, number of wells and the average daily and actual output in the United States:

	No. Producing Wells	Daily Average Output, Barrels	Nov. Actual Output, Barrels
Texas central and north	9,400	22.9	6,714,000
Gulf Coast	1,700	49.7	2,775,000
Total, Texas	11,100	27.0	9,489,000
California	9,490	32.3	9,340,000
Oklahoma	50,700	6.0	9,031,000
Kansas	15,700	7.4	3,578,000
Louisana	2,700	31.8	2,615,000
Wyoming and Montana	1,000	55.0	1,432,000
Illinois	16,800	1.7	846,000
Kentucky	7,800	3.2	734,000
West Virginia	19,500	1.1	656,000
Pennsylvania	67,600	0.3	603,000
Ohio	39,600	0.5	602,000
Indiana	2,400	1.1	81,000
New York	14,040	0.2	75,000
Total	258,600	4.98	39,090,000

Drying Storage Battery Plates

Low production cannot always be attributed to the inefficiency of labor, as seems to be the tendency these days. Very often it is due to antiquated equipment and obsolete methods of manufacture, which become the limiting factors in production, and no matter what speed is obtained up to this point the output of a plant is limited to the slowest operation in the process of manufacture.

Ninety per cent of all materials made must be dried at some stage of their manufacture, and generally speaking the drying operations require considerable time, varying from the fifteen minutes required for drying



MACHINE FOR DRYING STORAGE BATTERY PLATES

cotton and wool stock to from one to two weeks for high-tension porcelain insulators.

In the manufacture of storage batteries, the positive plates are formed by pasting a mixture of ammoniacal red lead into specially molded metallic lead grids, and the negative plates by pasting a mixture of lead peroxide into grids of the same type, the plate then being dipped into dilute sulphuric acid. Both positive and negative plates must then be thoroughly dried, since after the drying operation the plates are charged with electricity by the usual method and if there is even a small amount of moisture remaining in the plate the charging will cause the active material to crumble away from the grid and the plate must be discarded.

After the pasting process, the plates are inserted in racks preparatory to drying. Under the old system of drying the racks containing the plates were put into closets to dry. These closets were huge affairs of wood construction occupying a great amount of floor space and heated by means of steam coils which also formed the shelves for holding the racks containing the plates. As each rack was filled with wet plates, it had to be carried from the pasting table to the shelves on the closet. Here it required from twenty-four to forty-eight hours for the plates to dry, depending on the humidity of the surrounding atmosphere and with no certainty of uniform results or definite length of time to dry.

The length of time required to dry the plates by the old method and the lack of uniformity of results presented a serious obstacle to one of the largest storage battery manufacturers in this country when large-scale production was desired. The difficulty was practically overcome by the use of a Hurricane drier of the tunnel truck type, manufactured by the Philadelphia Drying Machinery Co., Philadelphia, Pa.

This machine is constructed of angle-iron framework to which panels are clamped, consisting of two sheets of steel, beveled and fastened together on the edges, thus forming an air-cell and providing insulation for the drier. The machine is divided into two compartments, one holding the steam coils which provide the heat for the drying, the other holding the trucks of plates being dried. The drying is accomplished by the circulation of large volumes of hot air by fans located in the partition between the two compartments.

After the plates are pasted and inserted into the racks, they are loaded on to a waiting truck and when fully loaded the truck is run into the drier. Here the plates are dried in a few hours, the time required depending on the area and thickness of the battery plate.

The drier is built to hold six specially constructed trucks in the drying chamber at one time, and as a truckload of wet plates is pushed into the machine at the feed end, a truckload of dry plates is removed from the delivery end, thus reducing labor and floor space to a minimum with the assurance that the material will be dried in a definite time.

Multiwhirl Subcooling Condenser

The construction of the multiwhirl subcooling condenser designed for use in oil refineries, particularly for the condensing and subcooling of gasoline, kerosene or any other vapors is shown by the accompanying cut. The vapors to be condensed enter the tubes at the top and are condensed and cooled in their passage through the tubes. The resulting distillate is taken off at the bottom, the tubes being arranged single pass. The condensing and cooling water enters the shell at the bottom and travels upward through the helical path and leaves the condenser at the top, this arrangement insuring contraflow operation.

SECTION PHOTOGRAPH OF CONDENSER

The unusual feature of this condenser, built by the Griscom-Russell Co. of New York, is the patented helical baffle, which insures a maximum length of water path for a given length of shell and a minimum water pressure loss. The helical baffle directs the water in its flow through the shell without appreciably retarding its progress.

The multiwhirl design permits a given size condenser in a much smaller space than has hitherto been possible because the efficiency secured by the use of the helical baffle permits the use of a much smaller amount of condensing and cooling surface than is ordinarily required. The efficient operation of the cooler permits delivery of the given cooling and condensing duty, using about one-third to one-quarter the condensing water required with other types of apparatus, with corresponding reduction in pumping costs. The high efficiency of

heat transfer results in a temperature of distillate within a few degrees of the condensing water supply. The helical baffle has been used for the past four years and is, therefore, a tried-out design which has been fully proved in other fields. The entire tube bundle may be removed from the shell, provided such removal is necessary for inspection and cleaning. The tubes are expanded into the tube plates without the use of sweated joints. The upper tube plate is rigidly attached to the shell, but the lower tube sheet floats and is free to move, thus preventing any expansion strains on tube joints. The floating head is outside packed and this construction prevents any possible leakage of water into the oil through faulty packing.

The condenser is made standard with shell of close grain cast iron, water head of cast iron or cast steel, and floating head of cast steel with floating head cover of either cast iron or steel. The tubes are of ⅝-in. O. D. No. 16 B.W.G. seamless drawn steel expanded into tube sheets of rolled steel. The helical baffle is of brass. These materials of construction are varied to suit the requirements of the particular installations.

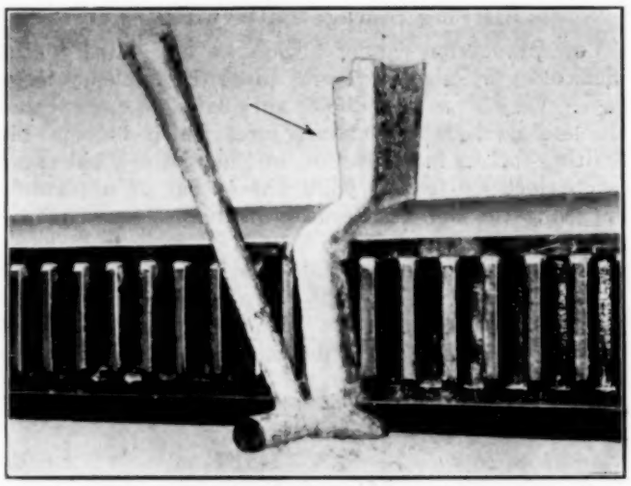
These condensers are built for both low or high pressure operations. They are especially well adapted to various cracking and topping systems. In making estimates on equipment installation, the following data should be had:

1. Pounds of vapor to be condensed per hour.
2. Gravity of liquid—degrees Baumé.
3. Latent heat of liquid.
4. Viscosity of liquid in Saybolt seconds.
5. Boiling point of liquid at working pressure.
6. Working pressure of vapor.
7. Inlet temperature of vapor.
8. Desired outlet temperature of condensate.
9. Per cent of non-condensible gases in vapor.
10. Can non-condensible gas be vented to atmosphere and if not what provision is made to take care of same?
11. Is steam present in vapor; if so how much?
12. Quantity of condensing water available per hour.
13. Temperature of water.
14. Water pressures—pounds per square inch.
15. Fresh or salt water?
16. If fresh, is it hard or soft?

Long Cast Sections Made by Welding Smaller Units

Ingot stripper plungers are extremely difficult to cast, owing to the fact that the cylinders, while 18 in. in diameter and 25 ft. or more long, have walls only 1 in. thick. Inasmuch as it is almost impossible to obtain a perfect core and then anchor it so as to prevent floating, the thickness of the steel is often reduced on certain sides, thereby weakening it and resulting in frequent breakages.

It has been found, however, that these castings can be made much more easily and of more uniform thickness by casting each cylinder in three separate parts about 10 ft. in length each, instead of in one piece, and then welding the parts together by means of thermit welding. All three welds can be machined off at the same time, and as the outside of the cylinder must be machined anyway, practically no more machining is required than if the plunger were cast in one piece. Plungers have been successfully welded in this manner for the past ten years and the welds have stood up perfectly in service.

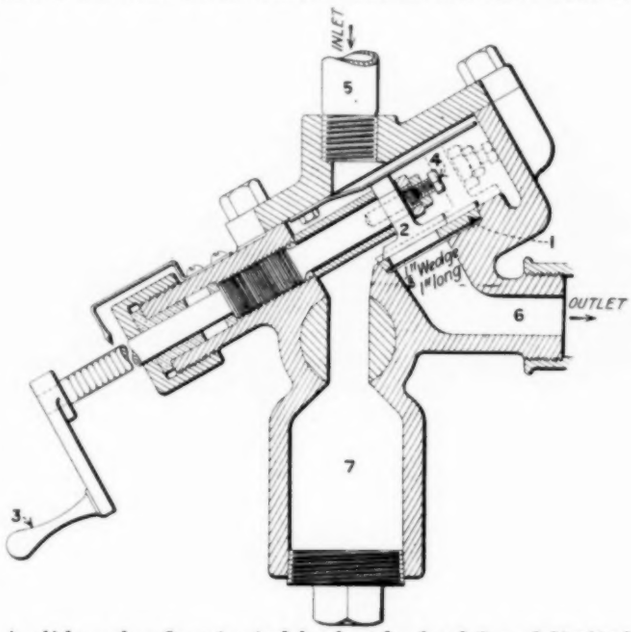


FRONT VIEW OF THERMIT WELDED INGOT STRIPPER PLUNGER AFTER HAVING BEEN CAST IN SMALLER SECTIONS

In the same way locomotive frames of unusual length for small foundries and other long sections which are difficult to cast in one piece can be cast in shorter lengths and these sections welded together. Welding may also be similarly used for building up shafts and other large sections in inaccessible places distant from transportation or underground in cramped quarters.

Flow-Regulating Valve for Viscous Liquids

The valve sectioned in the accompanying illustration was devised by A. V. Rigby, of the Carnegie Steel Co., and has given general satisfaction on open-hearth and reheating furnaces burning byproduct tar. A regulating orifice in the shape of a wedge 1 in. long and ½ in. wide at its base is cut in the valve seat 1.



A slide valve 2, actuated by hand wheel 3 and limited by an adjustable set screw 4 closely regulates the effective area of the opening through which the liquid must pass from inlet 5 to exit 6. In case the opening should be clogged, the slide 2 is brought forward, pushing the obstruction into the trap 7, while material sheared off by the under surface of the slide is washed out by the flow of liquid when the valve is reopened. Bailey-Lewis, Inc., of Pittsburgh, has the selling rights for this regulator.

Synopsis of Recent Chemical & Metallurgical Literature

Forge Press Operations.—A paper, very important to engineers responsible for forging operations, was presented by EUGÈNE SCHNEIDER before the autumn (1920) meeting of the British Iron and Steel Institute, entitled "An Investigation of Various Forging Operations Carried Out Under Hydraulic Presses." In it the author describes a recording instrument developed at the Creusot works, gives an illustration of the autographic and derived curves for a heavy forging job, and finally a diagram summarizing information on stamping thirty different calibers and designs of shells. By means of such graphs it is possible to predict confidently the proper treatment for strange forgings; hitherto, only a "cut-and-try" process had been the guide.

Fig. 1 shows a photograph of the recorder. A strip of paper is wound around drum *A* by means of wire *B* connected to the ram and wound in turn about the drum-end *C*, made slightly conical to compensate for the thickness of the overlapping paper. A pipe, as large and short as possible, connects the press cylinder to manometer *D*; pressure moves the pointer, and through the agency of a light sheave and silken cord, drives a tiny counterweighted pen carriage *E* at right angles to the paper-travel. Such a curve as that shown on the drum

FIG. 1. RECORDING INSTRUMENT FOR FORGING PRESSES

evidently records the position of the ram and the pressure in the cylinder at any instant. Times corresponding to these movements are recorded in a unique manner. A constant speed motor *F* drives an endless chain at right angles to the paper-edge. To this chain is attached pencils *G*, one of which is always making a mark on the paper. Since the transverse speed of the pencil is uniform, the slope of its trace is a measure of the speed with which the paper (that is, the ram) moves.

In order to record both up and down ram-movements on paper constantly moving in the same direction, wire *B* is pulled by a second drum, mounted on the same shaft as a fine-toothed ratchet wheel. To right and left of the latter and loose on the same shaft are mounted

TABLE I. SYNOPSIS OF PUNCHING

No.	Type of Forging	Weight in Kg.	Nature of Blank Employed— Diam. in mm.	Lgth. in mm.	Thickness of Bottom in mm.	Depth of Punching in mm.
1	75 mm. shrapnel	5.6	Round, 82	138	22	116
2	H.E. 75 mm. shell	7.8	Round, 82	190	30	160
3	Howitzer shell 58 mm	4.8	Round, 82	117	20	97
4	105 mm. shrapnel	13.3	Round, 115	165	30	135
5	155 mm. cartridge	17	Round, 172	95	22	73
6	H.E. howitzer shell, 120 mm.	28	Round, 138	240	30	210
7	H.E. howitzer shell, 105 mm.	23	Round, 115	285	40	245
8	H.E. howitzer shell, 155 mm.	56.5	Square, 145; diag., 186.	360	35	325
9	H.E. howitzer shell, 145 mm.	50	Round, 162	310	35	285
10	H.E. howitzer shell, 155 mm.	63	Round, 180	317	35	282
11	H.E. howitzer shell, 190 mm.	110	Round, 230	340	70	270
12	H.E. howitzer shell, 149 mm.	59	Round, 178	305	45	260
13	H.E. howitzer shell, 279 mm.	270	Square, 265; diag., 320.	540	70	470
14	Hydrogen gas shell	82	Square, 230; diag., 280.	210	20	190
15	H.E. shell, 293.4 mm.	345	Round, 320	545	80	465
16	H.E. shell, 279.4 mm.	270	Square, 270; diag., 365	480	70	410
17	H.E. shell 240 mm.	210	Square, 230; diag., 280	550	70	480
18	H.E. shell, 270 mm.	195	Square, 250; diag., 335.	410	70	340
19	Example of punching					
20	H.E. shell, 279.4 mm.	290	Square 280; diag., 350.	475	70	405
21	H.E. shell, 274.4 mm.	305	Square, 265; diag., 320.	595	70	525
22	H.E. shell, 320 mm.	485	Square, 280; diag., 350	820	80	740
23	H.E. shell, 370 mm.	650	Square, 368; diag., 430	665	75	590
24	H.E. shell, 370 mm.	530	Square, 268; diag., 430.	555	75	480
25	H.E. shell, 340 mm.	630	Square, 320; diag., 430.	795	90	705
26	H.E. shell, 400 mm.	800	Square, 368; diag., 430.	820	110	710
27	Torpedo tube	1,510	Octagon, diam., 480.	1,015	130	885
28	H.E. 520 mm.	1,250	Square, 465; diag., 550.	790	130	660
29	H.E., 520 mm.	1,800	Square 465; diag., 550.	1,130	130	1,000
30	H.E.	1,400	Octagon, diam., 580.	970	130	840

sprockets carrying counterweighted link chains fixed to the ram, but reeved oppositely. Thus when the ram is going down, the right sprocket ratchets the drum forward, and when the ram is being raised, the left sprocket ratchets the drum forward, the right sprocket then idling.

Calibration is effected by attaching a hand pump to *H*, holding a certain pressure, indicated by the standardized manometer *J*, and drawing the paper forward slightly. The time is checked by measuring with a stop watch the time necessary for, say, twenty complete circuits of the first pencil *G*, and computing its speed.

The diagram in Fig. 2 assembles information on forging of thirty different types of shells and tubes listed in Table I. Many different factors affect the work of forging *T* (defined as the necessary pressure in kg. per sq.mm. of the greatest diameter of the punch). After temperature—which is held constant at 1,050 deg. C.—the greatest influence is exerted by the thickness of the walls *e* (Fig. 3) and the diameter of the punch. The ratio between the area of the side wall (an annulus with thickness *e* and inner diameter *d*) and the area of the punch is noted by *Y* and is called the coefficient of spread.

$$Y = \frac{4e\ (d + e)}{d^2} \text{ and } Y \propto \frac{1}{T}$$

If the diameter of the punch *d* is constant, the work of forging *T* evidently decreases with increase in wall thickness *e*. If the wall thickness *e* is constant, the work of forging decreases with the diameter of the punch. Therefore, *Y* has been computed for each forging and plotted below the horizontal axis. Three general classes have been distinguished, the dotted lines referring to thin walled forgings ($Y = 0.76 \pm$), the continuous lines to medium-walled forgings ($Y = 0.95 \pm$), and the dot-and-dash line to thick forgings ($Y = 1.2 \pm$). Heavy lines below the axis also connect corresponding punch-diameters. Values of *Y* and *d* not falling near the curves such as for forging 24 present in general no anomalies.

The length of the stroke is of influence chiefly on account of the time the metal is pressed and cooled

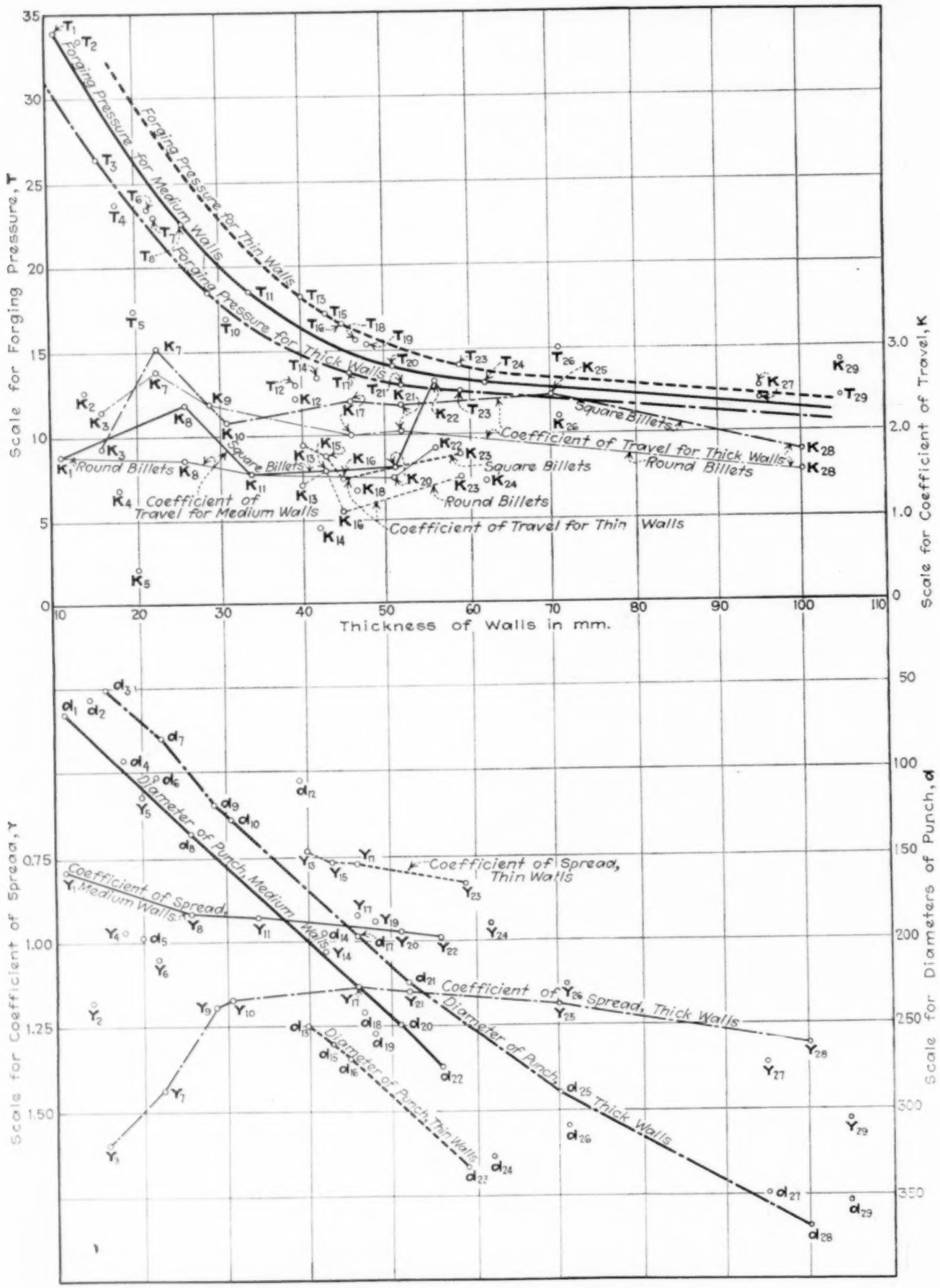

Scale for Forging Pressure, T
Scale for Coefficient of Travel, K
Thickness of Walls in mm.
Forging Pressure for Thin Walls
Forging Pressure for Medium Walls
Forging Pressure for Thick Walls
Square Billets
Round Billets
Coefficient of Travel for Thick Walls
Coefficient of Travel for Medium Walls
Coefficient of Travel for Thin Walls
Scale for Coefficient of Spread, Y
Scale for Diameters of Punch, d
Coefficient of Spread, Medium Walls
Coefficient of Spread, Thin Walls
Coefficient of Spread, Thick Walls
Diameter of Punch, Medium Walls
Diameter of Punch, Thin Walls
Diameter of Punch, Thick Walls

FIG. 2. DATA ON WORK REQUIRED FOR A PUNCHING OPERATION

Relationship between forging pressure in kilograms per square millimeter, diameter of punch, coefficient of spread and coefficient of travel for various operations, grouped in three classes.

against the die. The coefficient of travel K is defined as the ratio of length of stroke to diameter of punch, and is plotted above the horizontal axis, both for round and square billets, the latter being the higher. Other variables which have been eliminated are the shape and surface condition of punch and die, the speed of the press, the "spread" (or $e \div E$, see Fig. 3), the temperature of the tools, and the lubrication. Finally, the graph contains what is doubtless the most important information, viz., the work of forging, each point T being an integration of all these factors for a particular job, as determined with the aid of the recorder described above.

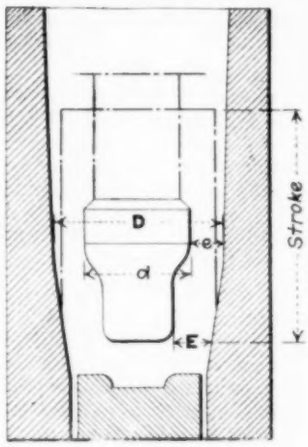


FIG. 3. SKETCH OF PUNCH AND DIE

As examples of the service to which this graph may be put, take the following:

(*a*) What pressure will be required to make a forging with $d = 255$ mm. and $e = 48$ mm.? Y is figured to be 0.89, consequently the work would be between that required for thin and for medium forgings. Running up ordinate 48, the required pressure is found to be about 15 kg. per sq.mm.

(*b*) Suppose a forging with $d = 255$ mm. is required and only a 650-ton press is available (a press which gives a maximum pressure of 12.8 kg. per sq.mm.). Running across abcissa 12.8 to its intersection with the curve T for thick forgings shows that a wall thickness of at least 60 mm. must be provided, and the die must evidently have a diameter not less than 375 mm. Y figures 1.16, consequently our assumption that the forging would lie in the "heavy" class is justified.

Other instruments may evidently be substituted for the manometer D (Fig. 1) and the working of a pump, machine tool or other machine can be studied. When applied to presses, it has furnished data for proper conversion of steam-driven pumps into electrically-driven pumps, and, as remarked above, for the solution of all forging problems connected with the scientific management of that department, enabling the production to be largely increased.

Recent Chemical & Metallurgical Patents

British Patents

Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Petent Office, Southampton Buildings, Chancery Lane, London, England.

Electrodes for Electric Arc Welding and Cutting.—In the manufacture of electrodes for the electric arc welding and cutting of metals the electrode covering consists, in addition to calcined magnesite, powdered aluminum and sodium silicate, of calcium carbonate and either graphite, iron peroxide or ferrous silicate, or graphite in conjunction with iron peroxide or ferrous silicate. The electrode is thus rendered suitable for overhead or vertical welding or welding in confined positions where the electrodes have frequently to be bent, and also allows for the variability of the carbon and silicon contents of the metal core. In an example a powder is made consisting of 100 g. of calcined magnesite, 100 g. of calcium carbonate, 33 g. of powdered aluminum, and 33 g. of graphite, which is made into a paste by adding 11 to 12 fluid oz. of a solution of silicate of soda of strength indicated as 40 deg. on Twaddell's scale. The proportion of iron peroxide when used may be 75 parts by weight and of ferrous silicate 66 parts by weight. (Br. Pat. 152,257, H. W. BOORNE, London; Dec. 22, 1920.)

Treating Complex Ores.—Complex ores or their products are roasted with an alkali chloride at about 400 deg. C. or lower with access of air so as selectively to chloridize the lead and silver or at similar or higher temperature so as to chloridize all the metals, and the product is then leached with hot alkali chloride solution to dissolve the lead and some silver, and afterward, if desired, with a solution of sodium thiosulphate to extract the silver. The first leaching solution is treated with metallic zinc, galvanized iron, aluminum or the like to obtain the lead and silver, and the deposited metal may be compressed under water to avoid oxidation, and is finally melted down. The second leaching solution is mixed with a sodium chloride solution and similarly treated to obtain a richer argentiferous lead; or the metals may be obtained from both solutions electrolytically. The residue from the leaching is treated by the "acid-oil froth process" to obtain a zinc concentrate. (Br. Pat. 152,289; not yet accepted; H. J. E. HAMILTON, North Broken Hill, New South Wales; Dec. 22, 1920.)

Artificial Marble.—Artificial marble is produced by making several separate mixtures of different colors and consistency, superimposing the mixtures in layers, and stirring them together with or without shaking in such a manner as to avoid complete mixing. A dry mixture of 1 part portland cement, ½ part silver sand and ½ part pulverized marble is moistened with water to which is added coloring matter free from sulphuric acid to form a comparatively thick mortar. "Flame markings" are produced by mixing a similar composition of different color with a larger proportion of water, and the composition for veins with less water. These mixtures are superimposed and turned over with a trowel or the like to mingle the colors. The mass is then shaken in molds without compression, and after drying the face layer is ground off. For reinforced concrete, the marble mass is placed in the mold, and while still moist the reinforced concrete is superimposed. (Br. Pat. 152,359; not yet accepted; D. JAGER, Amsterdam, Holland; Dec. 22, 1920.)

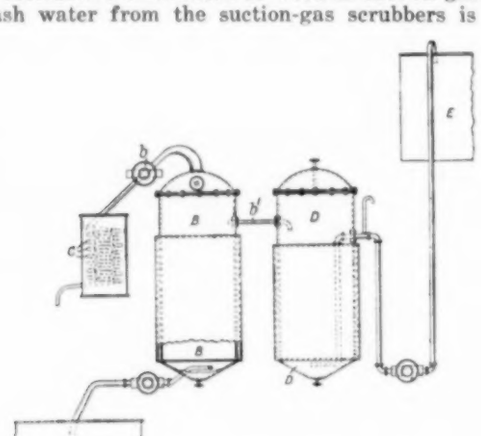
Alkali Percarbonates.—Solid alkali percarbonates are obtained by treating sodium carbonate with hydrogen peroxide in presence of sufficiently limited quantities of water to produce the solid product directly, and of sodium chloride for salting out the product. A previous calcination of the sodium carbonate and the addition of anti-catalyzers such as sodium silicate, magnesium chloride and magnesium-sodium silicate are advantageous. (Br. Pat. 152,366; DEUTSCHE GOLD & SILBER-SCHEIDEAUSTALT, VORM. ROESSLER, Frankfurt on Main; Dec. 22, 1920.)

Phenol-Aldehyde Condensation Products.—The condensation of phenols with formaldehyde or its equivalents is effected in the presence of a very small proportion of nitrocellulose or cellulose acetate; the maximum amount of cellulose ester used is about 0.8 per cent reckoned on the phenol. The use of nitrocellulose renders the product odorless, while cellulose acetate also confers increased toughness. In an example, cresylic acid, formaldehyde, caustic soda, and cellulose acetate (0.00025 per cent) are employed; the liquid product is boiled down, baked at atmospheric pressure, and may be further treated in an autoclave. (Br. Pat. 152,384; A. W. WELLER and W. T. ROBINSON-BINDLEY, both in London; Dec. 22, 1920.)

Chromium and Its Alloys.—A process for obtaining chromium from chromic oxide or a mineral such as chromite, for the production of chrome-iron or chrome-steel alloys, comprises the thermo-reduction of the oxide of chromium with calcium carbide in the presence of an alkaline earth oxide, with or without the presence also in the mixture of one or more other reducing agents such as calcium silicide or aluminum. The alkaline-earth oxide is preferably present in proportion at least equal molecularly to that of the calcium carbide. The reaction may be carried out within molten steel and the mixture may be inclosed in thin sheet-iron cases to be immersed in the molten steel. (Br. Pat. 152,399, W. B. BALLANTINE, London; Dec. 30, 1920.)

Anhydrous Magnesium Chloride for the Manufacture of Magnesium and Magnesium Alloys; Magnesium Chlorate.—Hydrated magnesium chloride is converted into the anhydrous body by partial dehydration in a voluminous current of heated air, preferably dried, until the fusion point is raised above 150 deg. C., followed by treatment with a slow current of hydrochloric acid gas to complete the dehydration. During dehydration, fusion of the mass is to be avoided, and the product obtained is porous if a temperature of 500 deg. C. is not exceeded, and of a partly crystalline texture if the temperature is allowed to rise to incipient fusion, 650 deg. C. After dehydration, the product may be fused. The magnesium chloride is preferably employed in the form of needle crystals such as are obtained by cooling a solution having a strength of 80 deg. Tw. from 50 deg. C. to atmospheric temperature. (Br. Pat. 152,401.) The fused anhydrous magnesium chloride, free or practically so from other substances, is used as electrolyte in both a primary and secondary cell. (Br. Pat. 152,402.) The chlorine obtained as a byproduct is absorbed in magnesium oxide emulsion producing magnesium chloride and chlorate, which are separated by crystallization, and the magnesium chloride is again used in the process. To render the process continuous, an additional supply of chlorine is admitted to the absorber. (Br. Pat. 152,403, E. A. ASHCROFT, London; Dec. 30, 1920.)

Acetic Acid, Methyl Alcohol; Acetone.—In order to recover the acetic acid, methyl alcohol and acetone formed by the destructive distillation of wood in suction gas plants, the wash water from the suction-gas scrubbers is passed



over chalk or barium carbonate until a sufficient concentration of acetate is obtained, and at the same time the methyl alcohol and acetone are withdrawn by means of vacuum. The wash water contained in the tank *A* is pumped into the vessel *B*, provided with a heating jacket, where it passes through lumps of calcium or barium carbonate and overflows through the pipe *b*' into the vessel *D*, which also contains calcium or barium carbonate and is fitted with a cooling-jacket. The methyl alcohol and acetone are drawn off from the heated wash water in the vessel *B* by means of the pump *b* into the condensing coil *C*. The liquid issuing from the vessel *D* is pumped into the tank *E*, from which it can be run back to the scrubbers of the suction-gas plant. The process is repeated until the content of calcium or barium acetate is sufficient to justify its recovery by evaporation. (Br. Pat. 152,420, J. C. ROBERTS, Hull, England; Dec. 30, 1920.)

Coloring Wood.—In coloring wood black or gray by means of a solution of iron and a solution of tannin, the wood is dried between the successive impregnations and is finally treated with ammonia or other alkali. Logwood extract may be used instead of, or in addition to, tannin, to modify the color. Impregnation may be effected with the aid of vacuum and pressure, and the process may be carried out in the cold or with the application of heat. (Br. Pat. 152,427, R. E. SLADE, London; Dec. 30, 1920.)

Intermediate Products; Dyes.—4-Nitro-2-naphthol is obtained by diazotizing 2:4-dinitro-1-naphthylamine with nitrosyl sulphate or sodium nitrite in concentrated sulphuric acid, pouring the diazo solution into water to precipitate 4-nitronaphthalene-1-diazo-2-oxide, and heating this diazo-oxide with ethyl alcohol, alone or in the presence of a metallic catalyst such as zinc, copper, aluminum or a zinc-copper couple, or a reducing agent such as hypophosphorous acid.

2:4-Dinitro-1-naphthylamine is prepared either by heating 2:4-dinitro-1-naphthol with alcoholic ammonia at 200 deg. C., or by dinitrating an acyl-α-naphthylamine or aryl-sulphonyl-α-naphthylamine—e.g., aceto-α-naphthalide or *p*-toluenesulphon-α-naphthalide—and hydrolyzing the product—for example, by heating with sulphuric acid.

Azo dyes are obtained in substance or on the fiber by coupling diazo or tetrazo compounds with 4-nitro-2-naphthol; the following products are specified: A dark red wool dye from diazotized sulphanilic acid; an orange dye from diazotized *p*-nitraniline-*o*-sulphonic acid; a purple cotton dye from tetrazotized 4:4'-diaminostilbene-2:2'-disulphonic acid; a purple cotton dye from diazotized safranine; and azo dyes on the fiber from *p*-nitraniline (bluish-red), 2:4-dinitraniline (red), dianisidine (dark blue), and primuline (reddish-brown). (Br. Pat. 152,437, G. T. MORGAN, Birmingham, and BRITISH DYESTUFFS CORPORATION, London; Dec. 30, 1920.)

Purifying Benzene.—Sulphur compounds are removed from benzene and other light oils by treatment at 30 to 90 deg. C. with sulphuric acid of 60 to 85 per cent strength, as by boiling the oil with acid of 73 to 82 per cent strength, or by passing the oil vapor through acid of 70 per cent strength at 84 deg. C. In an example, 500 gal. motor benzene are agitated with 50 gal. acid of 82 per cent strength for about two hours at 83 deg. C. in a sulphonator fitted with a reflux condenser, and the purified benzene is separated by distillation or gravity. (Br. Pat. 152,470, SOUTH METROPOLITAN GAS CO., E. V. EVANS and H. HOLLINGS, London; Dec. 30, 1920.)

Solder for Aluminum and Aluminum Alloys.—A solder for aluminum or its alloys is made from 6 lb. of tin, 2 lb. of zinc, 1½ lb. of aluminum, ¾ lb. of lead and ¼ lb. of an alloy of equal parts of copper and aluminum. The ingredients are melted in a graphite crucible with cryolite and lithium fluoride, and the product is fluxed with manganese chloride and run into bars. In use, the solder is applied to the heated aluminum surface; the coated surface may then be united to another similarly treated surface, or may be soldered by means of ordinary soft solder. (Br. Pat. 152,486, H. J. ANSELL, London; Dec. 30, 1920.)

Tanning.—Material to be treated by any tanning, impregnating or like process is submitted to a preliminary treatment consisting in subjecting it to the action of an electric current in pure water. This is stated to shorten and render more economical the subsequent process and also to have a deliming effect. The preliminary treatment in pure water may be conducted with diaphragms or the hide, etc., may be suspended between two poles and subjected to the electric current. The subsequent treatment may comprise electro-osmotic tanning or mechanical tanning or a combination of these processes. In an example, an oxhide delimed with dilute formic acid is electrically treated in pure water for ten hours, being then electro-osmotically tanned in chestnut wood extract of 2 deg. Bé. and subsequently mechanically tanned with a similar extract of 3 deg. Bé. (Br. Pat. 152,641; not yet accepted; ELEKTRO-OSMOSE AKT. GES., Berlin; Dec. 30, 1920.)

Current Events
in the Chemical and Metallurgical Industries

Nitrogen Corporation Bill Sleeping in Committee

At this writing there is apparently little chance for the bill providing for the formation of the U. S. Fixed Nitrogen Corporation. After passing the Senate the bill was referred to the Committee on Military Affairs of the House. Hearings were announced to begin on Feb. 3, but subsequently it was stated that the witnesses, each of whom favored the passage of the bill, had withdrawn their requests to be heard.

There is general feeling that the friends of the bill still have a card or two to play. The effort probably will be made to attach the bill to an appropriation measure as a rider.

Significance is attached to the fact that the Senate Committee on Appropriations has added to the sundry civil bill the $10,000,000 appropriation for the continuance of work on the dam at Muscle Shoals. The Committee on Appropriations of the House refused to embody this item in the bill it formulated. An effort to put the item in on the floor of the House was unsuccessful.

Chemical Warfare Service Appropriation

Instead of the $8,000,000 requested by General A. A. Fries for the Chemical Warfare Service during the next fiscal year, the Committee on Appropriations has embodied $1,500,000 in the Army appropriation bill, which was reported to the House Jan. 29. While the estimates of all War Department activities were reduced one-half on the average, there is a very decided feeling on the part of many members of Congress that the importance of chemical warfare is entitled to more than the committee has reported, which is less than one-half of 1 per cent of the funds made available in the Army appropriation bill.

General Fries states that the appropriation is entirely inadequate and that under it the Chemical Warfare Service not only will lose much ground but will be handicapped in its efforts to keep abreast with other nations in the study of war gases.

In explaining to the Committee on Appropriations the need for a larger appropriation, General Fries pointed out that he needed no less than $1,754,000 for his investigatory work alone. He revealed that fifty-two separate lines of investigation have been approved by the War Department. Some of these are subdivided so that one item has as many as a dozen subdivisions. Seventy per cent of the amount appropriated, General Fries stated, goes for the salaries of technical employees and the wages of common laborers. To cut the appropriation, General Fries told the committee, means that the work will require twice or three times as long as would be the case were the desired appropriation allowed.

"We worked this over with extreme care," said General Fries, "to get it down as low as possible. We do not want to build up a big force, but we do feel that we are charged with the defense of the entire Army against all chemical warfare materials. These materials affect every man in the Army from the commanding general down to the last private.

"We are operating eleven plants at Edgewood. These expenses at this time are at the rate of $1,000,000 per annum. In addition, we have the proving ground at Lakehurst, N. J., and we are operating sixteen salt wells at Midland, Mich., from which we get bromine. The Chemical Warfare Service sank these wells and built the plant to connect them up during the war. The brine is turned over to the Dow Chemical Co. to manufacture bromine salts. The manufacture of the salts into the bromine itself is done by us at Edgewood. The company has a contract to furnish 1,000,000 lb. of these salts. The net cost is 30c. a lb. Delivery will be completed before the end of the current fiscal year."

General Fries told the committee that at the present time the service consists of fifty-nine officers and 900 men out of a total authorized allowance of 100 officers and 1,200 enlisted men. The quota of officers has not been filled, because commissions in the service are unattractive to men possessed of the proper qualifications.

In regard to the chemists employed by the service, General Fries submitted a list of his civilian chemists as follows: One at $6,000, one at $4,500, three at $3,600, one at $2,100, one at $2,000, one at $1,800, one junior chemist at $2,400, three junior chemists at $2,000, twenty junior chemists at $1,800, one junior chemist at $1,760, one junior chemist at $1,740, one junior chemist at $1,700, four junior chemists at $1,620, two junior chemists at $1,500, five associate chemists at $3,000, two associate chemists at $2,800, one associate chemist at $2,700, three associate chemists at $2,600, five associate chemists at $2,500, one associate chemist at $2,475, thirteen associate chemists at $2,400, one associate chemist at $2,300, one associate chemist at $2,290, one associate chemist at $2,220, two associate chemists at $2,160, seven associate chemists at $2,100.

Oil From Pennsylvania Shales

Experiments to determine the amount of oil obtainable from Pennsylvania coals and black shales were begun in 1918 by Charles R. Fettke. A preliminary report on this work has been issued recently in mimeographed form by the Pennsylvania Geological Survey. Yields of oil, ammonia and gas (all based on a ton of 2,000 lb.) are given in tabulated form for eighty-four samples. There are also given for comparison results of tests made in the same way on cannel coals of other states and on rich Western oil shales.

The data show that Pennsylvania is not well supplied with rich oil-producing coals or shales. The conditions that produced the valuable anthracite in the eastern part of the state and the high-carbon coals in the eastern part of the bituminous fields drove the oil and gas out of the black shales of those regions, so that good results were obtained only from the coals and black shales in the extreme western and northwestern counties of the state.

Connecticut Valley Section, A.C.S., February Meeting

An interesting program is promised for the next meeting of the Connecticut Valley Section of the A.C.S., which is to be held at the Hotel Elton, Waterbury, Conn., on Feb. 14. Dr. John S. Shearer, professor of physics at Cornell University, will give an illustrated lecture on "Some Recent Applications of X-Rays in the Study of Metals."

Chemical Warfare Service Resolution to Be Submitted to the A.C.S.

A resolution deploring the limitations being placed upon the appropriations for the Chemical Warfare Service and the lack of sympathy shown for this service within the military establishment of the Government probably will be submitted to the American Chemical Society at an early date.

Refractory Plant of Baker Steel Co. Destroyed by Fire

Practically the entire reduction plant of the Basic Refractories, Inc., a subsidiary of the Baker Steel Co. of Pennsylvania and located in Natural Bridge, N. Y., was destroyed by fire on Jan. 24. The loss was $100,000.

Hearings Against Shadyside-Edgewater Plants Postponed

On Jan. 29 an adjourned hearing was heard in New York City before Herman Biggs, Commissioner of Health of the State of New York, to hear the complaint of the West End Association and the city against certain chemical manufacturers with plants in the State of New Jersey.

The concerns involved are: The Barrett Co., the General Chemical Co., the Corn Products Refining Co. and Spencer Kellogg & Sons, Inc. As these corporations all do business in New York State, these hearings have been held to give the defendants an opportunity to explain their actions. Chapter 292, Laws of 1917, provides an amendment to the General Corporation Laws of the state, whereby offending corporations may be prevented from doing business within the state, if they continue to commit such nuisances as that in question. Action was begun in 1918 by a group of persons who live in Riverside Drive and the western part of New York City. It was claimed that during periods of a west wind the fumes given off by these four plants rendered the air foul and made life miserable for the residents. The defendant companies were given until Jan. 1, 1921, to install fume-, gas- and stench-consuming devices in their plants, and shortly after that date the chief engineer of the New York State Department of Health made an investigation.

The General Chemical Co. had been accumulating residues from the distillation of acetic acid. These had been stored in tanks and had been covered with ashes in order to prevent the diffusion of the fumes. The Barrett Co. operates a felt saturating machine on its property and has now installed hoods over the machines so that the fumes may be led to a scrubber. The Corn Products Refining Co. has on its premises a corn-grinding plant, and it proposes to lead the fumes from the grinding mill under the boilers so that they may be consumed. It was found necessary to line the flues with Monel metal, as all other linings were corroded by the fumes. The Spencer Kellogg Co. has on its property a plant for boiling or "aging" linseed oil. Experiments have been conducted in leading the vapors through or over slaked lime; they were also led through a scrubber. More recently the company has planned to lead the fume under the boilers and the tall smokestack so that they may be burned.

As all the defendants had shown a sincere desire to overcome the objections, they were given until March 19 to complete their fume-consuming devices. On that date a final hearing will be held in the New York Academy of Medicine. The interests of the city were looked after by Russell Tarbox, of the office of the Corporation Counsel, while the citizens' association was represented by W. H. Page.

The chemical plants involved in this complaint are all located at Shadyside-Edgewater (Bergen County), N. J., on the Hudson River opposite 125th St., New York.

Importance of Scientific Research

Saturday noon, Jan. 29, Dr. C. E. K. Mees, director of the Research Laboratory, Eastman Kodak Co., lectured before the City Club of Rochester on the importance of scientific research. The speaker pointed out the great advance in comfort and in the standard of living which had taken place in the last hundred years. This does not necessarily carry happiness with it; happiness comes from the spirit, but in material comfort, in material wealth, great progress has been made.

This gain in comfort and safety and wealth has come from the accumulated knowledge which is used by the technical men to produce at relatively low cost the roads and the railroads, the windows and the heating, the improved houses and the better food distribution.

The knowledge used by the technical men is applied science, and the science that is applied was made in the laboratories. Cheap glass came from the chemical laboratory in its final origin; it cannot be made without cheap alkali, and cheap alkali could not be made without an understanding of the chemistry of the alkaline metals which were first discovered by Humphry Davy. Electricity, which plays so great a part in modern life, is generated by the rotation of wire coils in a magnetic field, and it was Faraday in his laboratory who first found that electricity could be produced in this way. All war waged on disease is based on the knowledge that disease is produced by micro-organisms, and the existence of these micro-organisms was discovered by Pasteur; so that the history of every advance is that there is first a discovery in a laboratory, and then other discoveries are made which extend and parallel it, and then it is developed in its own and other laboratories, and then it is applied experimentally, and finally there comes the industrial development of its application. Each step involves the introduction of other knowledge from the common stock of knowledge—sometimes other parts of the same science, sometimes knowledge from another science. Modern industry, then, and all modern civilization are built on science.

If the standard of comfort is to be further increased in the future the most obvious thing to do is to use the means that have proved successful in the past and to attempt by the development of more knowledge to gain more wealth. The inventions which have been made in recent years, especially in the field of electricity, show what could be done in this direction. Vast savings have been made by the development of improved electric lamps and refined and cheapened methods for telephones and telegraph transmission. The great electric companies are spending millions on scientific research, but the speaker believes that the application of research on a large scale to industry has only just begun and may easily be extended enormously.

The greatest field for research is in directions which seem at first sight to offer no prospect of immediate profit. The X-ray was discovered in the course of an investigation of some very obscure actions of minerals on photographic plates. One of the greatest discoveries in lighting technique came during a study of the absorption of gases in an evacuated lamp. A study of the emission of electric corpuscles from a hot wire produced the new types of waves which are so important in connection with wireless. It is possible that by a study of the chemical atom and of the way in which it breaks up in certain cases it may be possible to produce artificially the breaking down of atoms and thus to get power from their disintegration which would far transcend anything that has been available before. Should this prove successful its possibilities for industrial and social development would be limitless.

"Journal of Electricity and Western Industry"

Enlargement of the editorial scope of the *Journal of Electricity* and a change in its name to *Journal of Electricity and Western Industry* were announced at a dinner given on Feb. 1 in the Palace Hotel, San Francisco. The date marked the thirty-fifth anniversary of the *Journal of Electricity*, which has been one of the McGraw-Hill publications since September, 1919. Robert Sibley will continue as editor of the enlarged paper.

The *Journal of Electricity and Western Industry* will devoted to the upbuilding of the West as an industrial section, and it will interpret Western progress through the application of electric power, light and heat in industries and homes. In its enlarged scope the publication will record the progress of the far West not only of the electrical industry as such but also of all industry dependent upon electrical energy. The fullest editorial support will be given to financing the huge building programs of the Western electrical utilities in the development of hydro-electric power, as this is held to be the greatest single asset of the West.

Another Big Refinery for Wood River, Ill

The Wilcox Oil & Gas Corporation, of Tulsa, Okla., plans the erection of a large oil refinery at Wood River, Ill. H. F. Wilcox, president of the corporation, announces that the refinery will have a capacity of 20,000 bbl. and will be connected with the mid-continent fields by a pipe line. The Standard Oil and Roxana Petroleum companies already have refineries at Wood River, and the Empire Refineries, Inc., has more than 400 acres there for a similar purpose.

Trade Trip to Caribbean Ports

A formal call to commercial and financial institutions in the Central West to join in the trade schools to the West Indies and Central America has been issued by the Mississippi Valley Association, Harry H. Merrick, president. The cruise will start March 12 from New Orleans and will occupy a term of three weeks in visiting Caribbean points.

Personal

A. E. ANDERSON, general manager of the Ivorydale plant of the Procter & Gamble Co. at Cincinnati, Ohio, was elected a vice-president and is succeeded by FRANK K. SKILLMAN as general factory superintendent. Mr. Skillman served the company in various positions for over eighteen years at the Port Ivory and Kansas City plants.

WALTER BENEKE has resigned his position as instructor of chemistry at Cooper Union to accept a position as chemist with the Monsanto Chemical Works, St. Louis, Mo. Prior to his connection with Cooper Union Mr. Beneke was with the Organic Salt & Acid Co. of Newark, N. J.

Colonel G. A. BURRELL has returned to New York City after spending three months in Europe investigating matters relating to petroleum.

JOHN DISARIO, chemist and metallurgist, is now in charge of the laboratory, electric furnace and heat-treating of the Joliette Casting & Forgings, Ltd., Joliette, Que.

Major R. C. DITTO has been transferred from the Infantry to the Chemical Warfare Service.

W. A. DUNKLEY, who has been a gas engineer on the staff of the Illinois State Geological Survey, has accepted a position with the U. S. Bureau of Mines and will be acting in charge of the Urbana Station of the Bureau. Mr. Dunkley will continue there the work on fuels processing with which he has been associated for some years past.

Dr. OTTO KRESS, for the past four years in charge of the pulp and paper work at the Forest Products Laboratory at Madison, Wis., left Jan. 25 to join the staff of the Consolidated Water Power & Paper Co., at Appleton, Wis. He will be engaged with technical problems in connection with the control and development of pulp and paper products. Dr. Kress graduated as doctor of philosophy and chemistry at Columbia University in 1909 and engaged in pulp and paper mill work with various companies, joining the Bachische Co., New York City, in 1912, where he remained until he took charge of the work at Forest Products Laboratory. He is one of the founders of the Technical Association of the American Pulp and Paper Industry.

R. B. LADOO, a mineral technologist on the staff of the Bureau of Mines, is inspecting deposits of non-metals in the South.

D. A. LYON, chief metallurgist, E. A. HOLBROOK, chief metal mining engineer, and H. E. MYER, chief clerk, of the U. S. Bureau of Mines, are in Berkeley attending a conference of the superintendents of the Bureau's Western experiment stations and the deans of the various mining schools with which the Bureau is co-operating.

Major C. W. MASON has been transferred from the Infantry to the Chemical Warfare Service. He will be assigned to the command of a battalion of gas troops at Lakehurst.

W. W. ODELL, who has been conducting fuels carbonization investigation at the Urbana Station of the U. S. Bureau of Mines, has been transferred to the Washington offices, where he will assist in lignite carbonization studies.

W. R. SMITH, professor of chemistry, Lewis Institute, Chicago, spoke before the Chicago Chemists' Club recently on "Why I Believe in Ions."

W. M. WEIGEL, a mining engineer who has been in the employ of the Missouri Cobalt Co., has been employed by the Bureau of Mines to specialize in non-metallic matters. He will be stationed at Tuscaloosa, Ala.

Current Market Reports

The Chemical and Allied Industrial Market

NEW YORK, Feb. 7, 1921.

Although numerous inquiries for various chemicals reached the market during the past week, actual business was not large and transactions were confined mostly to small lot trading. It is believed that the steady expansion in inquiries is a forerunner to an increase in business. The acute declining tendency of the market during the past few months, however, has created a feeling of extreme conservatism among the domestic consumers, and the apparent disposition is to operate for the present on a hand-to-mouth basis.

Speculative interests have gradually got out of the market and those close to the pulse of trading assert that conditions will be more normal by spring.

Prices on *solid caustic soda* have not varied materially during the week. It seems reasonable that as soon as resale spot supplies are exhausted, producers will come into their own in both caustic and soda ash. The general quotation heard in leading quarters ranged from $3.85@$3.95 per 100 lb. Moderate resale lots of *soda ash* in single bags were offered at $2.10 per 100 lb., spot New York. The movement in this commodity was quiet throughout the week, with the tone, however, quite steady. Odd lots of imported *chlorate of potash* are on the market at very attractive prices. Some are of the opinion that the supply is relatively small and that a few good buying orders will probably clean up stocks. Quotations in the local market are heard from 8@18c. per lb., depending upon the brand, quantity and seller. The inside figure is for foreign material, while the outside price is named by leading producers f.o.b. works. It is stated that a few large orders are in the hands of exporters, but the wide variance in prices has retarded any actual business.

Moderate quantities of resale *bichromate of soda* continued to reach the market at 8½@8¾c. per lb. Reports were current that slightly under this could be done in some quarters on firm business, but dealers in general were not inclined to shade the inside price. Second hands quoted March shipments at 9@9½c. per lb. Demand for *salt cake* seems to be holding well, with some export business noted. With glass manufacturers ready to resume more normal operations, the outlook for this commodity seems bright and prices are expected to strengthen materially. Quotations on spot range from $33@$35 per ton in bulk. Lower prices on *nitrate of potash* have been established by leading producers. The extreme range for pure double refined extends from 9½@12c. per lb., depending upon the grade and quantity. The inside price is for double bags of granulated and the outside figure for barrels of large crystals.

Lower prices are now effective for the different grades of refined *sulphur*. Sulphur flour, 100 per cent, pure sublimed, is offered at $2.50@$3 per 100 lb. in barrels. Bags are obtainable at $2.25@$2.75 per 100 lb., depending upon quantity. Sulphur roll, 100 per cent pure, ranges from $2@$2.70 per 100 lb., depending upon containers and quantity. Moderate quantities of resale *bleaching powder* were offered by second hands at 2¾c. per lb. in large drums f.o.b. Niagara Falls. Spot material was quoted at 3c. per lb. The market looked quite steady, with a marked improvement in inquiries and orders.

COAL-TAR PRODUCTS

While business in general in the coal-tar products market has been on a limited scale throughout the week, the tone has shown considerable improvement. Color manufacturers have not changed their attitude in regard to prices and the quotations heard at the beginning of the week were largely in force at the close. Good reports from various mills keep coming in showing a resumption in operations, with full time in some quarters. Resale lots of intermediates, while mostly in small quantities, are again a little more freely

offered. The crude market is showing somewhat more activity on some items, while others are still quiet.

Benzene is moving in better volume and prices continue steady around 30@36c. per gal. The consuming demand for *anthracene* is improving, but the supply is limited. Producers of prime white *naphthalene* flakes are firm in their prices at 9@10c. per lb., while resale lots are heard in various directions at 8@8½c. per lb. Producers' prices on U.S.P. *salicylic acid* are quoted around 27@30c. per lb. Business has been very limited of late, owing to the lack of interest shown by domestic consumers. Prices on *aniline oil* on spot are rather weak at 21@21½c. per lb. Producers' prices are still at variance and range from 23@28c. per lb. Resale lots are plentiful on the market and in more or less distress. Second hand lots of *beta naphthol*, technical, could be had in good volume at 30c. per lb., although sales have been made during the week as low as 28c. Producers are holding their prices up around 40@45c. per lb., although in some quarters contracts have been offered at 35c. The market is very much disturbed and buyers are entering bids at figures well below the market price.

Prices on *dimethylaniline* are generally unsteady, although somewhat firmer than last week. Offers are heard at 55c. per lb. in the resale market, while some holders are asking as high as 65c. Little business is being transacted and consumers seem unwilling to come into the market in spite of the comparatively low price. Second-hand lots of *diphenylamine* are offered in several directions at prices well below the cost to manufacture. Offers are made at 60c. per lb., but it is quite well understood that this figure could be shaded in the face of firm business. Producers are naming prices around 70@75c. per lb., according to quantity. Manufacturers' figures on *paranitraniline* are given around $1@$1.05 per lb. Reports are still current, however, that odd lots are being held down to 90c. per lb. in several quarters. In the absence of firm business it has been impossible to determine what is the actual market value.

A wide difference exists between producers' prices and the resale market on *paratoluidine*. Offers have been heard as low as $1.25 per lb., while one producer is still quoting as high as $1.60. The general quotation ranged from $1.30@$1.40 per lb. The consuming demand for *beta naphthylamine* continued of a moderate routine nature. Producers in some quarters say they are better able to supply regular quantities, and quote the sublime variety at $2.25@$2.40 per lb. Spot stocks of *phenol* are comparatively low and prices are holding fairly well around 10@11c. per lb. The inquiry has been very dull and actual sales were few. In view of the present scarcity of spot material any considerable amount of business would probably force prices up further. There seems to be little inclination, however, for the consuming trade to enter the market to any extent.

The Chicago Market

CHICAGO, Feb. 4, 1921.

Steady progress in the return to a solid price basis was marked by new contract figures on *soda ash* and *caustic soda*. *Soda ash*, previously quoted at $1.82½@$1.90 per 100 lb. for 48 per cent f.o.b. works, is now priced $1.72½@$1.75. This quotation is for carload quantities. *Caustic*, 60 per cent base, in car f.o.b. works is now $3.50@$3.60 per 100 lb., which is about 15c. under previous offerings. A good business is being maintained and present price seems firm. *Bleaching powder*, quoted on contracts at 3½c. per lb., is reported as selling as low as 2¾c. from second hands, spot demand being weak. Little interest is seen in *sal soda*, prices ranging from $2@$2.50 per 100 lb. out of local stock.

Barium chloride, in ample supply at $85@$90 per ton, seems to be getting topheavy from a recent influx of imported stock, and lower prices are looked for. *Bichromate of soda*, more plentiful in supply and weak in demand, is quoted at 9½c. per lb. from spot stock. *Soda cyanide* remains in short supply and the price is firm at 35c. per lb. *Soda prussiate* is weak, quotations ranging from 18@20c. per lb. Slackness in *glycerine* trade continues, with current quotation on c.p. grade being 20c. per lb., with but few transactions recorded.

Trading in *alcohol* is quiet, stocks being larger than seems justified by demand. The *ethyl* grade, 190 proof, is $5.10@$5.35 per gal.; *methyl* grade, 95 per cent, $1.28@$1.32 per gal.; *denatured*, complete, 75@80c. per gal. *Formaldehyde* remains down around 20@21c. per lb., with consumption slow.

VEGETABLE OILS

Declines have been noted in the entire line of vegetable oils during the past few weeks. Interest is lacking in crude *cottonseed oil*, offered for prompt shipment at 6c. per lb. f.o.b. valley. Texas offerings are 5¾c. per lb. Large lots of Manila grade *coconut oil* changed hands last week at 8¾c. per lb. in buyers' tanks f.o.b. Coast. This is nearly 1c. off former pricings. Ceylon grade is offered on the Coast at 9¾c. per lb. *Corn oil*, diminished in supply and still in weak demand, is offered for February delivery in sellers' tanks at 6½c. f.o.b. Chicago. *Soya bean oil*, also in poor demand, is nominally 10¾@11c. per lb. for edible grade, in Chicago stock. Inactivity in consuming industries is causing this market to continue weak on all items.

COAL-TAR PRODUCTS

The market for crudes is in a little better shape except in the case of *naphthalene*, which is still plentiful on the spot. Flakes are quoted at 9@10c. per lb. and balls at 10@11c., but it is reported that bone fide orders would produce sharp shading. *Benzene*, water white grade, is 33@33½c. per gal., and reports are heard of limited transactions at a lower figure. *Solvent naphtha* is weak in demand, water white grade being quoted at 28@30c. per gal. and crude at 16@19c.

Among the intermediates, *aniline oil* and *aniline salt* are representative. In the face of numerous inquiries the price is off, the oil being offered at 29@30c. per lb. by producers and down as low as 22c. by second hands. The salt is a little firmer, 29@32c. being the quoted range, with some business done at the lower figure. *Benzyl chloride* is subject to lively inquiry and the current quotation is around 28c. on the 95 per cent and 23c. on the crude.

The St. Louis Market

ST. LOUIS, Feb. 4, 1921.

The feeling of cheerfulness reported two weeks ago has spread until heavy chemical producers are looking forward to a resumption of a fair amount of activity during the month of February. This optimistic mood of producers is being backed up to some extent by buyers. One of the largest producers reports that orders are coming better at present than at any time during the last forty days and that shipments scheduled for February will be considerably higher than those for January. It is admitted, however, that even with the present increase in sales the market would be characterized as somewhat slow during normal times.

The 98 deg. *sulphuric acid* is being shipped in fair amounts on a quotation of $24 per ton f.o.b. works. The market for the 66 deg. sulphuric acid has held up well during the past two weeks, the demand being fairly strong, and the price remaining unchanged at $20@$21 per ton and 1¾c. per lb. in carboys. The demand for the 60 deg. sulphuric acid is quiet. It is being quoted at $16 per ton and 1½c. per lb. in carboys. Inquiries for *oleum* continue good, with sales bettering somewhat. Producers are asking $28.50 per ton.

Muriatic acid is showing flashes of activity and production has increased somewhat. Current quotations are 1¾@2c. per lb. in carboys and $25 per ton in bulk.

The demand for *sodium bisulphate* has slowed down to a very conservative level once more, though shipments on contract are holding up well. It is being quoted at $7 to $8 per ton.

Nitric acid is in better demand with prices at the same level as they were two weeks ago. Quotations are $7 per 100 lb. for the 36 deg. test and $10 per 100 lb. for the 42 deg. Standard mixed acid is unchanged in price from its quotation of two weeks ago, 1½c. per lb. of sulphuric content and 11½c. per lb. of nitric content.

The Iron and Steel Market

PITTSBURGH, Pa., Feb. 4, 1921.

The stagnation in the iron and steel market is even more pronounced than at any previous time in this depression. That, however, is what should have been expected, since there has been no such change in fundamental economic or financial conditions as would produce an improvement.

Readjustment in commodity prices and wage rates is by no means completed, if indeed it is more than well begun. As to financial conditions, if the operation of the Federal Reserve banking system prevented the development of a panic or financial crisis, then the fundamental conditions that usually cause such a phenomenon must have been present and their other results must be expected. The steel industry has noticed recently a great slowing down in payments in some quarters, and as it normally does a cash business, this is a suggestive symptom.

The rate of pig iron production by merchant furnaces and independent steel works furnaces has continued to decrease. Taking the iron and steel industry as a whole and considering the high operating rate of the Steel Corporation on the one hand and the low operating rate of the independent steel works and the merchant blast furnaces on the other, the rate of production in both pig iron and steel ingots is now approximately 60 per cent of actual productive capacity.

STEEL PRICES

While there are many rumors in circulation of cut prices being made, that is, as noted in last report, really a psychological phenomenon always observed in the steel industry in a time of depression. In previous periods most of the rumors proved unfounded, and that is the case now. With the exception of plates, steel prices in general are being very well held indeed. As to plates, the market should be quoted at 2.50c. rather than at the Industrial Board price of 2.65c. There is no question that plates have been and can be bought at 2.50c., although not only the Steel Corporation but several independents are rigidly adhering to the 2.65c. figure. Otherwise the market remains quotable at Industrial Board prices: Bars, 2.35c.; shapes, 2.45c.; blue annealed sheets, 3.55c.; black sheets, 4.35c.; galvanized sheets, 5.70c.; plain wire, 3.25c.; wire nails, $3.25; standard steel pipe, 57½ per cent basing discount; hoops, 3.05c.; tin plate, $7 per base box, 100 lb. The tin plate quotation is on "production plates." Mills having odd lots in stock would probably sell such material at the usual concessions, and there are stocks held by middle interests, chiefly intended originally for export, that can be picked up at $6 or less by those who are content to take misfit sizes.

Nuts and bolts, reduced last week by fully 20 per cent, following other reductions last year, have been quite steady, although not in good demand. They may be regarded as one of the manufactures of steel that have been fully adjusted down to the mill prices now ruling for their raw material. Rivets are 4c. and railroad spikes 3.65c., prices that suggest need of further revision. This week the base price of chain was reduced from 7.25c. to 6.75c., while the differentials for smaller sizes were reduced, whereby some sizes are reduced altogether by 1c. and others by 1.25c. The war control price was 7.50c., the lowest price since then, during the second half of 1919, having been 5.75c. The quoted price refers to 1-in. proof coil chain.

PIG IRON

There have been offerings of foundry iron by producers on the basis of $29, valley basis, or $1 under what was previously quotable as the market, but buyers show no interest in this price and no disposition to suggest a price in which they would be interested. Bessemer and basic remain quotable at $32 and $30 respectively, but these prices are altogether nominal, subject to revision by furnaces in case any disposition is shown to buy even a moderate sized tonnage. At the meeting of the American Pig Iron Association stocks in merchant furnace yards were reported as slightly under 400,000 tons, and undelivered tonnage on books 1,500,000 tons, equal to about seven weeks of production at a fairly full rate or four months at present rate.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	–	$0.55 – $0.60
Acetone	lb.	$0.13 – $0.13½	.13½ – .14
Acid, acetic, 28 per cent	100 lbs.	3.00 – 3.25	3.50 – 3.75
Acetic, 56 per cent	100 lbs.	6.00 – 6.25	6.50 – 6.75
Acetic, glacial, 99½ per cent, carboys	100 lbs.	10.50 – 11.00	11.25 – 11.50
Boric, crystals	lb.	.14½ – .15	.15½ – .16
Boric, powder	lb.	.15½ – .16½	.17 – .18
Citric	lb.	–	.46 – .48
Hydrochloric	100 lb	1.60 – 1.75	1.85 – 2.25
Hydrofluoric, 52 per cent	lb.	.15 – .16	.16½ – .18
Lactic, 44 per cent tech	lb.	.10 – .11	.11½ – .12
Lactic, 22 per cent tech	lb.	.04½ – .05½	.06 – .07
Molybdic, C. P	lb.	4.00 – 4.50	4.50 – 5.00
Muriatic, 20 deg. (see hydrochloric)		–	–
Nitric, 40 deg	lb.	.07 – .07½	.08 – .08½
Nitric, 42 deg	lb.	.08½ – .09	.09½ – .10
Oxalic, crystals	lb.	.18 – .18½	.18½ – .19
Phosphoric, Ortho, 50 per cent solution	lb.	.15 – .15½	.16 – .16½
Picric	lb.	.30 – .32	.35 – .40
Pyrogallic, resublimed	lb.	–	2.30 – 2.40
Sulphuric, 60 deg., tank cars	ton	–	–
Sulphuric, 60 deg., drums	ton	–	14.00 – 15.00
Sulphuric, 66 deg., tank cars	ton	18.00 – 19.00	–
Sulphuric, 66 deg., drums	ton	21.00 – 22.00	22.50 – 23.00
Sulphuric, 66 deg., carboys	ton	–	–
Sulphuric, fuming, 20 per cent (oleum), tank cars	ton	23.00 – 24.00	–
Sulphuric, fuming, 20 per cent (oleum), drums	ton	25.00 – 26.00	26.50 – 27.00
Sulphuric, fuming, 20 per cent (oleum), carboys	ton	32.00 – 35.00	40.00 –
Tannic, U. S. P	lb.	–	1.15 – 1.25
Tannic (tech.)	lb.	.45 – .47	.48 – .50
Tartaric, crystals	lb	–	.33 – .35
Tungstic, per lb. of WO	lb.	–	1.20 – 1.40
Alcohol, Ethyl	gal	–	5.10 – 5.50
Alcohol, Methyl (see methanol)		–	–
Alcohol, denatured, 188 proof	gal.	–	.65 – .67
Alcohol, denatured, 190 proof	gal.	–	.68 – .70
Alum, ammonia lump	lb.	.04½ – .04¾	.05 – .05½
Alum, potash lump	lb.	.05½ – .06	.06½ – .07
Alum, chrome lump	lb.	.13 – .13½	.14 – .14½
Aluminum sulphate, commercial	lb	.02½ – .02¾	.02½ – .03
Aluminum sulphate, iron free	lb.	.03 – .03½	.03½ – .03¾
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.07 – .07½	.07½ – .08
Ammonia, anhydrous, cyl. (100-150 lb.)	lb.	.30 – .32	.33 – .35
Ammonium carbonate, powder	lb.	.11½ – .11¾	.12 – .12½
Ammonium chloride, granular (white salamoniac) (nominal)	lb.	.08½ – .08¾	.08½ – .09½
Ammonium chloride, granular (gray salammoniac)	lb.	.09 – .09½	.09½ – .10
Ammonium nitrate	lb.	.09 – .09½	.10 – .10½
Ammonium sulphate	100 lb.	3.30 – 3.40	3.50 – 3.75
Amylacetate	gal.	–	4.25 – 4.50
Amylacetate tech	gal.	–	3.50 – 3.75
Arsenic oxide, (white arsenic)	lb.	.10 – .10½	.10½ – .11
Arsenic, sulphide, powdered (red arsenic)	lb	.14 – .14½	.15 – .15½
Barium chloride	ton	65.00 – 70.00	75.00 – 80.00
Barium dioxide (peroxide)	lb.	.24 – .25	.26 – .27
Barium nitrate	lb.	.10 – .10½	.10½ – .11
Barium sulphate (precip.) (blanc fixe)	lb.	.04½ – .05	.05½ – .06
Bleaching powder (see calc. hypochlorite)		–	–
Blue vitriol (see copper sulphate)		–	–
Borax (see sodium borate)		–	–
Brimstone (see sulphur, roll)		–	–
Bromine	lb.	.50 – .52	.54 – .56
Calcium acetate	100 lbs.	2.00 – 2.05	–
Calcium carbide	lb.	.04 – .04½	.04½ – .05
Calcium chloride, fused, lump	ton	27.00 – 29.00	30.00 – 32.00
Calcium chloride, granulated	lb.	.01½ – .02	.02½ – .02¾
Calcium hypochlorite (bleaching powder)	lb.	.02½ – .03	.03½ – .03¾
Calcium peroxide	lb.	–	1.25 – 1.30
Calcium phosphate, monobasic	lb.	–	.16 – .18
Camphor	lb.	–	.80 – .85
Carbon bisulphide	lb.	.08 – .08½	.09 – .09½
Carbon tetrachloride, drums	lb	.12 – .12½	.13 – .13½
Carbonyl chloride (phosgene)	lb.	–	.75 – 1.00
Caustic potash (see potassium hydroxide)		–	–
Caustic soda (see sodium hydroxide)		–	–
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.09 – .09½	.10 – .10½
Chloroform	lb.	–	.43 – .50
Cobalt oxide	lb.	–	3.10 – 3.20
Copperas (see iron sulphate)		–	–
Copper carbonate, green precipitate	lb	.22 – .22½	.24 – .25
Copper cyanide	lb.	–	.50 – .60
Copper sulphate, crystals	lb	.06½ – .06½	.06½ – .07½
Cream of tartar (see potassium bitartrate)		–	–
Epsom salt (see magnesium sulphate)		–	–
Ethyl Acetate Com. 85%	gal.	–	1.05 – 1.10
Ethyl Acetate pure (acetic ether 98% to 100%)		–	–
Formaldehyde, 40 per cent	lb.	.18 – .18½	.18½ – .19
Fusel oil, ref	gal	–	3.50 – 3.60
Fusel oil, crude	gal.	–	2.75 – 3.00
Glauber's salt (see sodium sulphate)		–	–
Glycerine, C. P. drums extra	lb	–	.20 – .21
Iodine, resublimed	lb	–	3.85 – 4.00
Iron oxide, red	lb.	–	.10 – .20
Iron sulphate (copperas)	100 lb.	1.25 – 1.50	1.75 – 2.00
Lead acetate, normal	lb.	–	.14½ – .16
Lead arsenate (paste)	lb	.11 – .12	.12½ – .13
Lead nitrate	lb.	–	.15 – .20
Litharge	lb.	.08½ – .09	.09½ – .10
Lithium carbonate	lb.	–	1.50 –
Magnesium carbonate, technical	lb.	.10½ – .11	.11½ – .12
Magnesium sulphate, U. S. P	100 lb	2.50 – 3.00	–
Magnesium sulphate, commercial	100 lb	–	1.50 – 1.75
Methanol, 95%	gal	–	1.30 – 1.40
Methanol, pure	gal	–	1.50 – 1.60
Nickel salt, double	lb.	–	.12 – .12½
Nickel salt, single	lb.	–	.13 – .13½
Phosgene (see carbonyl chloride)		–	–
Phosphorus, red	lb.	.45 – .46	.47 – .50
Phosphorus, yellow	lb.	–	.35 – .37
Potassium bichromate	lb.	.14½ – .14¾	.15 – .15½

		Carlots	Less Carlots
Potassium bitartrate (cream of tartar)	lb.	$ — $ —	$0.33 — $0.35
Potassium bromide, granular	lb.	— —	.20 — .40
Potassium carbonate, U. S. P.	lb.	.35 — .40	.45 — .50
Potassium carbonate, crude	lb.	.11 — .11½	.11 — .12
Potassium chlorate, crystals	lb.	.08 — .10	.11 — .18
Potassium cyanide	lb.	— —	.65 — .70
Potassium hydroxide (caustic potash)	lb.	.14 — .14½	.15 — .16
Potassium muriate	ton	75.00 — 80.00	— —
Potassium iodide	lb.	— —	3.00 — 3.20
Potassium nitrate	lb.	.09½ — .10	.10 — .12½
Potassium permanganate	lb.	.48 — .50	.52 — .60
Potassium prussiate, red	lb.	.50 — .52	.53 — .55
Potassium prussiate, yellow	lb.	.26 — .26½	.27 — .27½
Potassium sulphate (powdered)	per unit	— —	— 2.25
Rochelle salts (see sodium potassium tartrate)		— —	— —
Salammoniac (see ammonium chloride)		— —	— —
Sal soda (see sodium carbonate)		— —	— —
Salt cake	ton	— —	33.00 — 35.00
Silver cyanide	oz.	— —	1.25 —
Silver nitrate	oz.	— —	.43 — .44
Soda ash, light	100 lb.	2.10 — 2.15	2.20 — 2.30
Soda ash, dense	100 lb.	2.20 — 2.25	2.30 — 2.50
Sodium acetate	lb.	.05½ — .05½	.06 — .06½
Sodium bicarbonate	100 lb.	2.50 — 2.75	3.00 — 3.25
Sodium bichromate	lb.	.08½ — .08½	.08¾ — .09
Sodium bi-sulphate (nitre cake)	ton	7.00 — 7.50	8.00 — 11.00
Sodium bi-sulphite powdered, U. S. P.	lb.	.06¼ — .06½	.06¾ — .07½
Sodium borate (borax)	lb.	.07 — .07½	.07½ — .08
Sodium carbonate (sal soda)	100 lb.	2.00 — 2.25	2.50 — 2.75
Sodium chlorate	lb.	.10 — .10½	.10½ — .11
Sodium cyanide, 96-98 per cent	lb.	.20 — .21	.22 — .28
Sodium fluoride	lb.	.13 — .14	.14½ — .15
Sodium hydroxide (caustic soda)	100 lb.	3.85 — 3.90	3.95 — 4.25
Sodium hyposulphite	lb.	— —	.03½ — .04
Sodium nitrate	100 lbs.	2.85 — —	3.00 — —
Sodium nitrite	lb.	.06 — .06	.06½ — .07
Sodium peroxide, powdered	lb.	.30 — .34	.32 — .34
Sodium phosphate, dibasic	lb.	.03½ — .04½	.04 — .05
Sodium potassium tartrate (Rochelle salts)	lb.	— —	.31 — .32
Sodium prussiate, yellow	lb.	.16½ — .17	.17½ — .17½
Sodium silicate, solution (40 deg.)	lb.	.01½ — .01½	.02 — .02½
Sodium silicate, solution (60 deg.)	lb.	.03 — .03½	.03½ — .04
Sodium sulphate, crystals (Glauber's salt)	100 lbs.	1.75 — 2.00	2.25 — 2.50
Sodium sulphide, crystal, 60-62 per cent (conc.)	lb.	.05 — .05½	.05½ — .06
Sodium sulphite, crystals	lb.	.04 — .04½	.04½ — .05
Strontium nitrate, powdered	lb.	.17½ — .18	.18½ — .18½
Sulphur chloride, red	lb.	.07 — .07½	.07½ — .08
Sulphur, crude	ton	16.00 — 18.00	— —
Sulphur dioxide, liquid, cylinders	lb.	.08 — .08½	.08½ — .09
Sulphur (sublimed), flour	100 lb.	— —	2.25 — 3.10
Sulphur, roll (brimstone)	100 lb.	— —	2.00 — 2.75
Tin bichloride, 50 per cent	lb.	.18 — .19	— —
Tin oxide	lb.	— —	.48 — .50
Zinc carbonate, precipitate	lb.	.16 — .18	.19 — .20
Zinc chloride, gran.	lb.	.11½ — .12	.12½ — .13
Zinc cyanide	lb.	.45 — .49	.50 — .60
Zinc dust	lb.	.12 — .13	.13½ — .14
Zinc oxide, XX	lb.	.08½ — .09	.09½ — .11
Zinc sulphate	lb.	.03½ — .03¾	.04 — .06

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb.	$1.10 — $1.15
Alpha-naphthol, refined	lb.	1.45 — 1.50
Alpha-naphthylamine	lb.	.38 — .40
Aniline oil, drums extra	lb.	.21 — .27
Aniline salts	lb.	.27 — .30
Anthracene, 80%, in drums (100 lb.)	lb.	.75 — 1.00
Benzaldehyde (f.f.c.)	lb.	2.00 — 2.10
Benzidine, base	lb.	1.00 — 1.10
Benzidine sulphate	lb.	.80 — .90
Benzoic acid, U. S. P.	lb.	.70 — .75
Benzoate of soda, U. S. P.	lb.	.70 — .80
Benzene, pure, water-white, in drums (100 gal.)	gal.	.30 — .35
Benzene, 90%, in drums (100 gal.)	gal.	.28 — .32
Benzyl chloride, 95-97%, refined	lb.	.30 — .35
Benzyl chloride, tech.	lb.	.25 — .30
Beta-naphthol benzoate	lb.	3.50 — 4.00
Beta-naphthol, sublimed	lb.	.75 — .80
Beta-naphthol, tech.	lb.	.30 — .35
Beta-naphthylamine, sublimed	lb.	2.25 — 2.40
Cresol, U. S. P., in drums (100 lb.)	lb.	.16 — .18
Orthocresol, in drums (100 lb.)	lb.	.23 — .25
Cresylic acid, 97-99%, straw color, in drums	gal.	.95 — 1.00
Cresylic acid, 75-97%, dark, in drums	gal.	.90 — .95
Cresylic acid, 50%, first quality, drums	gal.	.65 — .75
Dichlorbenzene	lb.	.06 — .09
Diethylaniline	lb.	1.25 — 1.30
Dimethylaniline	lb.	.55 — .65
Dinitrobenzene	lb.	.30 — .32
Dinitrochlorbenzene	lb.	.25 — .30
Dinitronaphthalene	lb.	.33 — .35
Dinitrophenol	lb.	.40 — .45
Dinitrotoluene	lb.	.25 — .30
Dip oil, 25%, tar acids, car lots, in drums	gal.	.37 — .40
Diphenylamine	lb.	.60 — .70
H-acid	lb.	1.30 — 1.50
Meta-phenylenediamine	lb.	1.25 — 1.30
Monochlorbenzene	lb.	.14 — .16
Monoethylaniline	lb.	2.00 — 2.10
Naphthalene crushed, in bbls. (250 lb.)	lb.	.08 — .08½
Naphthalene, flake	lb.	.08 — .08½
Naphthalene, balls	lb.	.09 — .09½
Naphthionic acid, crude	lb.	.70 — .75
Nitrobenzene	lb.	.12 — .15
Nitro-naphthalene	lb.	.30 — .35
Nitro-toluene	lb.	.18 — .25
Ortho-amidophenol	lb.	3.20 — 3.75
Ortho-dichlor-benzene	lb.	.15 — .20
Ortho-nitro-phenol	lb.	.75 — .80
Ortho-nitro-toluene	lb.	.22 — .24
Ortho-toluidine	lb.	.25 — .30
Para-amidophenol, base	lb.	1.90 — 2.00
Para-amidophenol, HCl	lb.	2.10 — 2.20
Para-dichlorbenzene	lb.	.15 — .25
Paranitroaniline	lb.	.90 — .95
Para-nitrotoluene	lb.	.90 — 1.05
Para-phenylenediamine	lb.	1.83 — 2.20
Para-toluidine	lb.	1.30 — 1.60
Phthalic anhydride	lb.	.55 — .60
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.10 — .12
Pyridine	gal.	2.00 — 3.50
Resorcinol, technical	lb.	1.85 — 2.00
Resorcinol, pure	lb.	2.75 — 3.00
Salicylic acid, tech., in bbls. (110 lb.)	lb.	.23 — .25
Salicylic acid, U. S. P.	lb.	.27 — .30
Salol	lb.	.85 — .95
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.28 — .32
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.16 — .18
Sulphanilic acid, crude	lb.	.30 — .35
Tolidine	lb.	1.40 — 1.60
Toluidine, mixed	lb.	.45 — .50
Toluene, in tank cars	gal.	.30 — .32
Toluene, in drums	gal.	.33 — .35
Xylidines, drums, 100 gal.	lb.	.45 — .50
Xylene, pure, in drums	gal.	.42 — .45
Xylene, pure, in tank cars	gal.	.45 — ....
Xylene, commercial, in drums, 100 gal.	gal.	.33 — .35
Xylene, commercial, in tank cars	gal.	.30 — ....

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark	lb.	$0.24 — $0.26
Beeswax, refined, light	lb.	.27 — .28
Beeswax, white pure	lb.	.40 — .45
Carnauba, No. 1	lb.	.75 — .80
Carnauba, No. 2, North Country	lb.	.35 — .40
Carnauba, No. 3, North Country	lb.	.18 — .19
Japan	lb.	.19 — .20
Montan, crude	lb.	.07 — .08
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.04½ — .05½
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.04¼ — .04½
Paraffine waxes, refined, 118-120 m.p.	lb.	.06 — ....
Paraffine waxes, refined, 125 m.p.	lb.	.06½ — ....
Paraffine waxes, refined, 128-130 m.p.	lb.	.07¼ — ....
Paraffine waxes, refined, 133-135 m.p.	lb.	.08 — .08½
Paraffine waxes, refined, 135-137 m.p.	lb.	.10 — ....
Stearic acid, single pressed	lb.	.12½ — ....
Stearic acid, double pressed	lb.	.13¼ — ....
Stearic acid, triple pressed	lb.	.14 — ....

Flotation Oils

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp.gr., 0.930-0.940	gal.	$1.70
Pine oil, pure, dest. dist.	gal.	1.60
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.	.48
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.	.75
Pine tar, ref., thin, sp.gr., 1.080-1.960	gal.	.36
Turpentine, crude, sp. gr., 0.900-0.970	gal.	1.20
Hardwood oil, f.o.b. Mich., sp.gr., 0.950-0.990	gal.	.37
Pinewood creosote, ref.	gal.	.55

Naval Stores

The following prices are f.o.b. New York for carload lots.

Rosin B-D, bbl.	280 lb.	$8.50 — .....
Rosin E-I	280 lb.	8.50 — .....
Rosin K-N	280 lb.	8.50 — .....
Rosin W. G.-W. W.	280 lb.	8.75 — .....
Wood rosin, bbl.	280 lb.	9.00 — .....
Spirits of turpentine	gal.	65 — .....
Wood turpentine, steam dist.	gal.	64 — .....
Wood turpentine, dest. dist.	gal.	63 — .....
Pine tar pitch, bbl.	200 lb.	— 8.50
Tar, kiln burned, bbl. (500 lb.)	bbl.	— 15.00
Retort tar, bbl.	500 lb.	15.00 — 15.50
Rosin oil, first run	gal.	.52 — .....
Rosin oil, second run	gal.	.54 — .....
Rosin oil, third run	gal.	.62 — .....

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$0.41
70-72 deg., steel bbls. (85 lb.)	gal.	.39
68-70 deg., steel bbls. (85 lb.)	gal.	.38
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.30

Crude Rubber

Para—Upriver fine	lb.	$0.18½ — $0.19
Upriver coarse	lb.	.14 — .14½
Upriver caucho ball	lb.	.14½ — .14½
Plantation—First latex crepe	lb.	.18½ — .....
Ribbed smoked sheets	lb.	.17½ — .....
Brown crepe, thin, clean	lb.	.18 — .....
Amber crepe No. 1	lb.	.20 — .....

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	$0.09½ — $0.10
Castor oil, AA, in bbls.	lb.	.11 — .11½
China wood oil, in bbls. (f.o.b. Pac. coast)	lb.	.08½ — .08½
Cocoanut oil, Ceylon grade, in bbls.	lb.	.12 — .12½
Cocoanut oil, Cochin grade, in bbls.	lb.	.12½ — .13
Corn oil, crude, in bbls.	lb.	.08½ — .09
Cottonseed oil, crude (f. o. b. mill)	lb.	.06 — .06½
Cottonseed oil, summer yellow	lb.	.08½ — .09
Cottonseed oil, winter yellow	lb.	.09 — .09½
Linseed oil, raw, car lots (domestic)	gal.	.70 — .71
Linseed oil, raw, tank cars (domestic)	gal.	.63 — ....
Linseed oil, boiled, car lots (domestic)	gal.	.72 — .73

Olive oil, commercial	gal	$2 25 —	$2 40
Palm, Lagos	lb.	07½ —	07¾
Palm, Niger	lb.	07 —	07¼
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	06¾ —	07
Peanut oil, refined, in bbls	lb.	13 —	13½
Rapeseed oil, refined in bbls	gal	1 10 —	1 15
Rapeseed oil, blown, in bbls	gal.	1 20 —	1 25
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.08 —	08½
Soya bean oil, tank cars, f.o.b., Pacific coast	lb	.05¼ —	

FISH

Light pressed menhaden	gal.	$0 48 —	$0 50
Yellow bleached menhaden	gal.	50 —	52
White bleached menhaden	gal.	52 —	54
Blown menhaden	gal.	88 —	

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	$24 00 —	30 00
Barytes, ground, off color, f.o.b. Kings Creek	net ton	22 00 —	26 00
Barytes, crude, 88° @ 94°, ba., Kings Creek	net ton	10 00 —	12 00
Barytes, floated, f.o.b. St. Louis	net ton	26 50 —	28 00
Barytes, crude, first grade, Missouri	net ton	10 00	
Blanc fixe, dry	lb.	05 —	05½
Blanc fixe, pulp	net ton	50 00 —	60 00
Casein	lb.	14 —	18
Chalk, domestic, extra light	lb.	05 —	06
Chalk, domestic, light	lb.	04 —	05½
Chalk, domestic, heavy	lb.	04 —	05
Chalk, English, extra light	lb.	05 —	07
Chalk, English, light	lb.	05 —	06
Chalk, English, dense	lb.	04 —	05
China clay (kaolin) crude, f.o.b. mines, Georgia	net ton	8 00 —	10 00
China clay (kaolin) washed, f.o.b. Georgia	net ton	12 00 —	15 00
China clay (kaolin) powdered, f.o.b. Georgia	net ton	18 00 —	22 00
China clay (kaolin) crude f.o.b. Virginia points	net ton	8 00 —	12 00
China clay (kaolin) ground, f.o.b. Virginia points	net ton	15 00 —	40 00
China clay (kaolin), imported, lump	net ton	25 00 —	35 00
China clay (kaolin), imported, powdered	net ton	30 00 —	35 00
Feldspar, crude, f.o.b. Maryland and North Carolina points	gross ton	8 00 —	14 00
Feld-par, crude, f.o.b. Maine	net ton	7 50 —	10 00
Feld-par, ground, f.o.b. Maine	net ton	21 00 —	23 00
Feldspar, ground, f.o.b. North Carolina	net ton	17 00 —	21 00
Feldspar, ground, f.o.b. N. Y. State	net ton	17 00 —	21 00
Feldspar, ground, f.o.b. Baltimore	net ton	27 00 —	30 00
Fullers earth, f.o.b. Mines	net ton	16 00 —	17 00
Fullers earth, granular, f.o.b. Fla	net ton	25 00	
Fullers earth, powdered, f.o.b. Fla	net ton	18 00	
Fullers earth, imported, powdered	net ton	35 00 —	40 00
Graphite, crucible, 90°, carbon, Ashland, Ala	lb.	—	09
Graphite, crucible, 85°, carbon, Ashland, Ala	lb.	07 —	09
Graphite, higher lubricating grades	lb.	11 —	40
Pumice stone, imported, lump	lb.	04 —	50
Pumice stone, domestic lump	lb.	06	
Pumice stone, ground	lb.	04 —	07
Quartz (acid tower) first to head, f.o.b. Baltimore	net ton	—	10 00
Quartz (acid tower) 1½@2 in., f.o.b. Baltimore	net ton	—	14 00
Quartz (acid tower) rice, f.o.b. Baltimore	net ton	—	17 00
Quartz, lump, f.o.b. North Carolina	net ton	5 00 —	7 50
Shellac, orange fine	lb.	60	
Shellac, orange superfine	lb.	70	
Shellac, A. C. garnet	lb.	58	
Shellac, T. N.	lb.	55	
Soapstone	ton	15 00 —	25 00
Sodium chloride	long ton	—	17 50
Talc, paper-making grades, f.o.b. Vermont	ton	12 00 —	22 00
Talc, roofing grades, f.o.b. Vermont	ton	9 50 —	15 00
Talc, rubber grades, f.o.b. Vermont	ton	12 00 —	18 00
Talc, powdered, Southern, f.o.b. cars	ton	12 00 —	15 00
Talc, imported	ton	40 00 —	50 00
Talc, California talcum powder grade	ton	20 00 —	45 00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh	1,000		160
Chrome brick, f.o.b. Eastern shipping points	net ton	80 —	100
Chrome cement, 40–45% Cr_2O_3	net ton	45 —	50
Chrome cement, 40–45% Cr_2O_3, sacks, in car lots, f.o.b. Eastern shipping points	net ton	—	55
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	55 —	60
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	45 —	50
Magnesite brick, 9-in. straight	net ton		100
Magnesite brick, 9-in. arches, wedges and keys	net ton		105
Magnesite brick, soaps and splits	net ton		120
Silica brick, 9-in. sizes, f.o.b. Chicago district	1,000	65 —	70
Silica brick, 9-in. sizes, f.o.b. Birmingham district	1,000	56 —	61
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa	1,000	50 —	60

Ferro-Alloys

All f.o.b. Works

Ferrocarbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.	net ton	$200 00 —	$225 00
Ferrochrome per lb. of Cr. contained, 6–8% carbon, carlots	lb.	.16	
Ferrochrome, per lb. of Cr. contained, 4–6% carbon, carlots	lb.	.16 —	.17
Ferromanganese, 76-80% Mn, domestic	gross ton	100 00 —	
Ferromanganese, 76-80% Mn, English	gross ton	100 00 —	
Spiegeleisen, 18-22% Mn	gross ton	—	40 00
Ferromolybdenum, 50-60% Mo, per lb. of Mo	lb.	2 00 —	2 50
Ferrosilicon, 10-15%	gross ton	55 00 —	60 00
Ferrosilicon, 50%	gross ton	78 00 —	80 00
Ferrosilicon, 75%	gross ton	140 00 —	145 00
Ferrotungsten, 70-80%, per lb. of contained W	lb.	55 —	.60
Ferrouranium, 35-50% of U, per lb. of U content	lb.	7 00 —	
Ferrovanadium, 30-40% per lb. of contained V	lb.	5 00 —	6 50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content, less than 2% Fe_2O_3, up to 20% silica, not more than H 4% moisture	gross ton	$10 00 —	$11 00
Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	unit	.60 —	65
Chrome ore, 50% Cr_2O_3, f.o.b. Atlantic seaboard	unit	55 —	60
Coke, foundry, f.o.b. ovens	net ton	6 50 —	7 00
Coke, furnace, f.o.b. ovens	net ton	5 00 —	5 50
Coke, petroleum, refinery, Atlantic seaboard	net ton	21 00 —	22 00
Fluorspar, lump, f.o.b. Tonuco, New Mexico	net ton	15 00 —	
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	22 50 —	25 00
Ilmenite, 52% TiO_2, per lb. ore	lb.	01½ —	01
Manganese ore, 50% Mn, c.i.f. Atlantic seaport	unit	38 —	40
Manganese ore, chemical (MnO_2)	gross ton	60 00 —	65 00
Molybdenite, 85% MoS_2 per lb. of MoS_2, N. Y.	lb.	55 —	65
Monazite, per unit of ThO_2, c.i.f., Atlantic seaport	unit	30 00 —	
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	12 —	
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport	unit	16	
Pyrites, domestic, fines, f.o.b. mines, Ga	unit	12	14
Rutile, 95% TiO_2 per lb. ore	lb.	15	
Tungsten, scheelite, 60% WO_3 and over, per unit of WO_3 (nominal)	unit	3 00	3 25
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C.	unit	3 00	3 25
Uranium ore (carnotite) per lb. of U_3O_8	lb.	2 75	3 00
Uranium oxide, 96%, per lb. contained U_3O_8	lb.	2 75	3 00
Vanadium pentoxide, 99%	lb.	12 00	14 00
Vanadium ore, per lb. of V_2O_5 contained	lb.	1 50	
Zircon, washed, iron free	lb.	03 —	

Non-Ferrous Metals

New York Markets

	Cents per L...
Copper, electrolytic	14 00
Aluminum, 98 to 99 per cent	28 30@28 5
Antimony, wholesale lots, Chinese and Japanese	6 00
Nickel, ordinary (ingots)	43 00
Nickel, electrolytic	45 00
Monel metal, spot and blocks	35
Monel metal ingots	38
Monel metal, sheet bars	40
Tin, 5-ton lots	32 00
Lead, New York, spot	5 50
Lead, E. St. Louis, spot	5 00
Zinc, spot, New York	6 00
Zinc, spot, E. St. Louis	5 65

OTHER METALS

Silver (commercial)	oz.	$0 66½
Cadmium	lb.	1 40@1 5
Bismuth (500 lb. lots)	lb.	2 40
Cobalt	lb.	6 00
Magnesium (f.o.b. Philadelphia)	lb.	1 35
Platinum	oz.	75 00
Iridium	oz.	350 00@400
Palladium	oz.	75 00
Mercury	75 lb.	50 00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	21 00
Copper bottoms	33 00
Copper rods	28 00
High brass wire and sheets	18 75
High brass rods	16 75
Low brass wire and sheets	27 50
Low brass rods	18 50
Brazed brass tubing	35 25
Brazed bronze tubing	40 50
Seamless copper tubing	25 00
Seamless high brass tubing	24 00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York				
	Current	One Year Ago	Cleveland	Chicago	
Copper, heavy and crucible	11 50	18 50	10 00	10 50	
Copper, heavy and wire	11 00	16 50	9 50	9 50	
Copper, light and bottoms	9 00	14 50	9 00	8 50	
Lead, heavy	4 00	7 25	4 00	4 00	
Lead, tea	3 00	5 25	3 00	3 00	
Brass, heavy	7 00	9 50	7 00	10 00	
Brass, light	5 50	8 00	5 00	5 50	
No. 1 yellow brass turnings	6 00	9 50	5 50	6 00	
Zinc	4 00	5 00	3 00	3 50	

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named:

	New York			Cleveland		Chicago	
	*Current	One Month Ago	One Year Ago	Current	One Year Ago	Current	One Year Ago
Structural shapes	$3 73	$3 80	$3 47	$3 58	$3 37	$3 58	$3 47
Soft steel bars	3 93	3 70	3 52	3 34	3 27	3 48	3 52
Soft steel bar shapes	3 93	3 70	3 52	3 48	3 27	3 48	3 52
Soft steel bands	4 33	4 65	4 22	6 25			
Plates, ¼ to 1 in. thick	3 93	4 00	3 67	3 78	3 57	3 78	3 67

*Add 10c per 100 lb. for trucking to Jersey City and 15c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Colorado

LA VETA—City had plans prepared for construction of sewerage system, including Inhoff tank, gravel bed filtration and chlorine plants. J. O. Francisco, engr.

Florida

KISSIMMEE—Tucker Brick Co. plans to rebuild brick plant which was recently destroyed by fire. Estimated cost, $15,000.

Illinois

LITCHFIELD—City plans water-works improvements and construction of filtration plant. Estimated cost, $200,000. J. W. Allen, City Hall, city clk.

Indiana

INDIANAPOLIS—C. & A. Potts & Co., 816 West Washington Ave., plans to build 1-story, brick and steel foundry on Blake St. Estimated cost, $45,000. Architect not selected.

Iowa

BUFFALO CENTER—Consolidated School Dist. is having plans prepared for the construction of a 2-story, 82x145-ft. rein.-con. and brick high school here. A chemical laboratory will be installed in same. Estimated cost, $150,000. G. L. Lockhart, 294 Endicott Bldg., St. Paul, Minn., archt.

OTTUMWA—The Bd. Educ. will receive bids until Feb. 23 for construction of a 3-story rein.-con. and brick high school. A chemical laboratory will be installed in same. Estimated cost, $700,000. Croft & Boerner, 1006 Marquette Ave., Minneapolis, archts. Noted July 21.

UTE—C. W. Hitchen, city clk., will receive bids until Feb. 15 for the construction of about 19,000 lin.ft. vitr. pipe sewer, settling tank and twin filter beds. Estimated cost, $50,000. E. E. Carlson, Battle Creek, engr.

Illinois

SPRINGFIELD—City Water Dept. plans to build water softening and iron removal plant. Estimated cost, $75,000. Burns & McDonnell, 400 Interstate Bldg., Kansas City, Mo., engrs.

Michigan

DETROIT—Park Davis & Co., Atwater St. and McDougall Ave., will soon award the contract for construction of a 7-story, 200x248-ft. brick, steel and rein.-con. factory. Smith, Hinchman & Grylls, 710 Washington Arcade, archts. Noted Jan. 19.

GRAND RAPIDS—City will receive bids about Feb. 15 for construction of a filtration plant. Estimated cost, $400,000. R. E. Harrison, 1260 Nicholas Bldg., Toledo, engr.

Minnesota

COOKSTON—Miller Tanning Co., 615 Woodland Ave., having plans prepared for the construction of a 2-story, 50x50-ft. concrete tannery here. Estimated cost, $13,000. E. T. Gillies, 248 McKnight Bldg., Minneapolis, engr.

MANKATO—The Immanuel Hospital Association is having plans prepared for construction of a 3-story rein.-con. and brick addition to hospital on Washington and Ford Sts. A clinical and pathological laboratory and X-ray department will be installed in same. Estimated cost, $150,000. Schippel & Schmidt, Kruse Bldg., archts. Noted Dec. 8.

Ohio

CLEVELAND—Bd. Educ. is having plans prepared for the construction of a 3-story, brick and steel high school on East 116th St. and Corlett Ave. A chemical laboratory will be installed in same. Estimated cost, $2,000,000. W. R. McCormack, East 6th St. and Rockwell Ave., archt.

CLEVELAND—Bd. Educ. is having plans prepared for the construction of a 2-story, brick and steel high school in Collinwood Dist. A chemical laboratory will be installed in same. Estimated cost, $2,000,000. W. R. McCormack, East 6th St. and Rockwell Ave., archt.

GENEVA—Bd. Pub. Affairs will receive bids until Feb. 15 for enlarging and improving water filtration plant here, including construction of new filter plant with 1,000,000-gal. capacity. P. Burgess, 141 East Broad St., Columbus, engr.

GIBSONBURG—Kelly Island Lime & Transport Co., c/o J. A. Kling, pres., Leader-News Bldg., Cleveland, has awarded the contract for the construction of a 1-story, 50x130-ft. hydrating lime plant here, to Forst City Steel & Iron Works, 1500 West 110th St., Cleveland. Estimated cost, $50,000.

NEWARK—Leonard Oil Gas Co. plans to build an oil refinery here. Rust Engr. Co., 1901 Fifth Ave., Pittsburgh, Pa., engrs.

Oklahoma

MOUNTAIN VIEW—City is having preliminary plans prepared for construction of sewerage system and disposal plant. V. V. Long & Co., 1300 Colcord Bldg., Oklahoma City, engrs.

Pennsylvania

READING—Bd. Educ. 8th and Washington Sts., plans to build 3-story, 300x300-ft. concrete high school. A chemical laboratory will be installed in same. Architect not selected.

South Dakota

ABERDEEN—Bd. Educ. receives bids about April 2 for construction of a 3-story, rein.-con. and brick high school. A chemical laboratory will be installed in same. Estimated cost, $300,000. W. W. Beach Co., Sioux City, Iowa, archts.

BELLEFOURCHE—Bd. Educ. will soon receive bids on 42x60-ft. rein.-con. and brick first unit of a 2-story high school. A chemical laboratory will be installed in same. Estimated cost, $100,000. W. W. Beach Co., Sioux City, archts.

Tennessee

ALTON PARK—The Du Bois Rubber Co., 315 Volunteer Bldg., let contract for the construction of a 2-story, 40x50-ft. rubber plant here, to Chickamauga Quarry & Constr. Co., Chickamauga. Estimated cost, $100,000.

Texas

DALLAS—City plans the construction of a water purification plant, 15,000,000-gal. capacity. Estimated cost, $500,000. G. D. Fairtrace, city engr.

GRAHAM—City plans to construct reservoir dam on Salt Creek, extend water mains, enlarge pumping plant and filtration bed and extend and enlarge sewage disposal plant. Estimated cost, $100,000. H. E. Elrod Eng. Co., Interurban Bldg., Dallas, consult. engrs.

TERRELL—City has awarded the contract for the construction of a pump house and filtration system, including oil engines and 2 pumps, to Merkle Machinery Co., Tulsa, Okla. Estimated cost, $47,850.

WACO—Herring Ave. Methodist Church is having plans prepared for the construction of a 3-story, 75x100-ft. brick and concrete hospital on Herring Ave. A chemical laboratory will be installed in same. About $100,000. R. H. Hunt Co., Southwest Life Bldg., Dallas, archts.

Wisconsin

KAUKAUNA—Molock Co. is in the market for brass foundry equipment, including ovens.

RACINE—Wisconsin Gas & Electric Co., Public Service Bldg., Milwaukee, has awarded the contract for the construction of a 2-story, 40x60-ft. brick and concrete gas plant addition to Bingard & Christianson, 2220 Kinzie Ave.

Coming Meetings and Events

AMERICAN CERAMIC SOCIETY will hold its annual meeting Feb. 21 to 24 at Columbus, Ohio, with headquarters at the Deschler Hotel.

AMERICAN CHEMICAL SOCIETY will hold its sixty-first meeting at Rochester, N. Y., April 26 to 29.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting at Atlantic City April 21 to 23 inclusive. Headquarters will be at the Hotel Chalfonte.

AMERICAN ENGINEERING COUNCIL will meet at Syracuse, N. Y., Feb. 14 and 15.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its spring meeting June 20 to 24 at Detroit. Industrial excursions will be made to Ann Arbor, Saginaw, Midland and Bay City.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its spring meeting Feb. 14 to 17 in New York City.

AMERICAN OIL CHEMISTS' SOCIETY (formerly the Society of Cotton Products Analysts) will hold its twelfth annual meeting in Chicago May 16 and 17.

AMERICAN PAPER & PULP ASSOCIATION will hold its annual meeting at the Waldorf-Astoria and Hotel Astor, New York City, April 11 to 15.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS will hold its spring meeting at the Congress Hotel, Chicago, May 23 to 26.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its 1921 annual meeting in the New Monterey Hotel, Asbury Park, N. J., during the week of June 20.

CHAMBER OF COMMERCE OF THE UNITED STATES will hold its ninth annual meeting in Atlantic City April 27, 28 and 29.

NATIONAL PETROLEUM CONGRESS will meet at the Hotel Baltimore, Kansas City, Mo., March 22 to 25.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stetters Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

THE NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SEVENTH) will be held during the week of Sept. 12, in the Eighth Coast Artillery Armory, New York City.

DR. EDGAR F. SMITH will address the joint gathering of the New York Section of the American Electrochemical Society and the American Chemical Society, and the American sections of the Society of Chemical Industry and the Société de Chimie Industrielle at the Chemists' Club on the evening of Feb. 11. His subject is "Research."

The following chemical societies will meet at Rumford Hall, Chemists' Club, New York City, as follows: Feb. 11, American Electrochemical Society, joint meeting with Society of Chemical Industry, American Chemical Society and Société de Chimie Industrielle; March 11, American Chemical Society; March 25, Society of Chemical Industry; April 22, Society of Chemical Industry, joint meeting with American Electrochemical Society, Société de Chimie Industrielle and American Chemical Society; May 6, American Chemical Society, Nichols Medal award; May 13, Société de Chimie Industrielle, joint meeting with American Chemical Society, Society of Chemical Industry and American Electrochemical Society; May 20, Society of Chemical Industry; June 10, American Chemical Society.

Manufacturers' Catalogs

PITTSBURGH IRON & STEEL FOUNDRIES CO., Pittsburgh, Pa., is distributing an attractive booklet on "Adamite in the World's Work," which illustrates and describes the performance of Adamite under severe operating conditions.

THE NORTON CO., Worcester, Mass., calls attention to a catalog on "Balancing Equipment for Grinding Wheels." Illustrations and descriptive matter are given, together with prices.

WALLACE & TIERNAN CO., INC., New York City, announces Technical Publication 23 on "Modern Bleaching Methods," which are based on the use of liquid chlorine with control equipment.

THE HARDINGE CO., New York City, calls attention to Catalog 8, on the Hardinge conical mill, and Grinding Data No. 4 and No. 5.